The American Journal of Surgery

NEW SERIES, VOL. XIII SEPTEMBER, 1931 No. 3

SIMULTANEOUS LIGATION OF VEIN IN LIGATION OF LARGE ARTERIES

EXPERIMENTAL STUDY*

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IN the course of our studies on the physiological factors concerned in the development of collateral circulation in an extremity following the ligation of its main artery, we have studied at considerable length the effect of simultaneous ligation of the artery and vein. In a previous publication[1] we have stated our results on prolonged observation of temperature of extremities in dogs after ligation of the main artery. We were impressed by the rarity of gangrene in these animals after this procedure, and so were led to the experiments to be here reported.

It is our purpose in this paper to critically review the literature both clinical and experimental relating to this problem; and secondly, to present the results of our own experiments.

In the past fifteen years much has been written about the simultaneous ligation of the accompanying vein when a large artery is ligated, and there has been a certain measure of insistence on the part of some surgeons on the necessity of this procedure to prevent gangrene. There has also been some experimental work done both to prove that simultaneous vein ligation does increase the incidence of gangrene, and to attempt to explain how it does this.

While the occurrence of gangrene after ligation of the large arteries has always been a large problem for the surgeon, and ways have been sought to avoid it, the operation of simultaneous ligation of the vein seems to have had its inception about 1916, during the World War. Reference to the standard textbooks of surgery since 1900, will give some idea of the opinion on this subject current during the first twenty years of the present century. Bickham's "Operative Surgery"[2] (1905 edition; same in 1924 edition) says (p. 26): "When it is difficult to separate one or more veins from the artery, the artery and vein or veins may be included in the one ligature. When a large vein is wounded, the wound should be at once closed by lateral ligature or by suture, preferably the former. If this is not feasible, the vein should be ligated." Kocher's "Textbook of Operative Surgery"[3] (1911) does not mention simultaneous ligation of the accompanying vein in connection with the ligation of any of the large arteries, or in the indications for the ligature of the larger veins. Ashhurst's "Surgery"[4] (1914) in the rules for the ligation of wounded arteries does not suggest ligation of the companion vein, but says (p. 234): "According to Wolff's statistics (1908) gangrene occurred in 34 per cent of cases where both femoral artery and vein were ligated, and in only 8 per cent where femoral vein alone was ligated."

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Rose and Carless' "Manual of Surgery"[5] (1919) says:

> Ligature of the main artery does not produce gangrene in a healthy limb . . . Obstruction to both main artery and vein, if it occurs suddenly, has been looked on hitherto as an almost certain precursor of gangrene . . . As a matter of fact, at any rate in young and healthy people, the ligature of the main vein with the artery for wound of both vessels does not seem to add to the risk of gangrene, but rather to diminish it, and this by reducing the venous congestion in the limb. This has been so marked that military authorities advise that in wounds of the main artery requiring ligature, the vein though unwounded should be tied at the same time. This decision is a strange turnover of surgical practice; it is certainly true for young healthy soldiers with no generalized degeneration or disease of the vessel walls, but its truth will have to be tested for elderly people where arteries have to be tied for aneurysms.

Stewart's "Surgery"[6] (1921) states (p. 131): "Gangrene from ligature of the principal artery of a limb seldom occurs if the general health is unimpaired, and the limb sound. Obstruction of the principal artery and vein, the result of ligature or injury, is almost sure to be followed by gangrene." Da Costa's "Modern Surgery"[7] (1925) does not mention simultaneous vein ligation either as a help in preventing gangrene or as an added cause of gangrene in ligating the large arteries.

Keen's "Surgery"[8] (1909) mentions (p. 119) among the causes which interfere with the establishment of collateral circulation after ligation of a large artery, "the coincident obstruction of the satellite veins and lymphatics, thus favoring stasis in the peripheral circulation." The simultaneous ligation of the accompanying vein is not suggested in their "golden rules" for the ligation of bleeding arteries. In regard to venous ligation they say (p. 169), "the joint injury of both vessels is the most certain way of causing gangrene of the limb." In the supplement to Keen's "Surgery"[9] (1921) in the chapter on Military Surgery of the Vascular System, R. Matas says: "In fact, even when we come to the immediate treatment of these large bleeding or exposed blood vessels we are still going back to the Napoleonic Campaigns and applying the 'golden rules.' Sencert has kept notes on 70 cases in which he ligated the great vascular trunks in open wounds within the first few hours following the injury, and in *which* there *was no hematoma*. In all these 70 ligations there were only two gangrenes; one of these was a ligation of the femoral and the other of the popliteal. On the other hand, he ligated 42 arteries for diffuse hematoma, and counting only the ligatures which were applied to the large dangerous arteries, he had gangrene in 6 cases: 2 gangrenes in 5 axillary ligations; 2 in 10 femoral ligations, and 2 in 5 popliteal (or 30 per cent gangrenes). Therefore Sencert concludes in a general way that in large open wounds which are subject to thorough and systematic surgical cleaning, the ligature of the large arterial trunks when applied to healthy segments of the vessel is not only the simplest and safest procedure for the patient, but is also relatively safe for the limbs. Makins tabulates 86 ligations of the large vessels (axillary, brachial, femoral, popliteal) which were applied for hemorrhage at the front. These were followed by gangrene of the extremities in 8, or 10.5 per cent. The advocacy of Makins and other British surgeons of the simultaneous ligation of the satellite vein with the injured artery, as a means of increasing the low blood pressure in the peripheral circulation, and thereby tiding over the nutrition of the distal parts until the collateral circulation can be established, shows, if nothing else, that there is a growing appreciation of the urgent need for discrimination in the methods of treatment of wounded blood vessels at the front."

Lewisohn in the "Oxford Surgery,"[10] (1920) has this to say, "Since the introduction of aseptic surgery it has been found that not only the main artery, but also the main vein may be ligatured without risk of gangrene, and the two vessels may

even be tied simultaneously with a fair chance of gangrene being avoided, provided that the wound remains aseptic." However, in discussing what to do in case the vein has been punctured during ligation of the artery, he advises lateral ligature or suture.

The policy of simultaneous vein ligation is attributed to Sir George Makins, Surgeon of the British Army during the late war. In view of this it might be well to review his earlier opinion in the matter. In 1916 he reported[11] among other vascular injuries from the British service in the early part of the war, 36 cases of injuries to the femoral vessels: 15 of the common femoral, 7 superficial, 9 lower one-third, and 3 of the profunda. Of these, 25 had operations consisting without exception of ligation above and below the wound:

	No.	Deaths	
Common femoral...	5	2	6 deaths, or 24 per cent mortality
Superficial femoral..	17	3	
Profunda.....	2	1	
Int. circumflex.....	1	0	

Gangrene occurred seven times in the 36 cases, twice before ligation; 1 had "trench feet," 1 followed two severe secondary hemorrhages in a patient dying of septicemia, 1 involved only the toes. In 1 case only it followed the operation of ligature. In all these cases the patients had severe wound infection. So it seems at the time he published this paper Makins did not advise simultaneous vein ligation, and still considered that injury or occlusion of the vein was to be avoided if possible. And considering his statistics on the femoral artery with only one gangrene following the operation of ligation in 25 cases of severely infected war wounds, it is hard to see how the results could be improved.

It is true that Makins in the Bradshaw lecture of 1913[12] commenting on experiences in the Boer War noted that there was a smaller incidence of gangrene in cases of arteriovenous fistula treated by ligation of the artery and vein, than in those treated by ligation of the artery alone. But this is a situation altogether different from the ligation of the healthy vein with no fistulous involvement. A similar observation had been reported in 1908 by Oppel[13] in a vivid and dramatic description of an operation for axillary artery-vein aneurysm done in 1906. Again in 1913 Oppel[14] used and recommended ligation of the popliteal vein for treatment of senile gangrene of the foot.

Before Makins in the actual advocacy of ligation of the healthy vein, the German surgeon, Sehrt[15] in 1916 made the statement:

> The outflow or better the sucking up of the venous blood may be best prevented by ligation of the veins. Everything which accelerates the sucking away of the venous blood (activity of the heart, etc.) from an extremity robbed of its arterial supply must contribute to the death of the part deprived. Thus may be explained cases in which definite gangrene of a segment of an extremity has appeared some little time after the receipt of the injury and after the general condition and especially the heart's force had improved. Everyone may well have seen such cases. Under certain circumstances a severely injured member may be carried over the most dangerous period by venous blockage.

It would seem that the improvement in the general condition, and the force of the heart beat would have just as much effect, if not more, in opening up the arterial collaterals as it would in sucking away the blood from the venous system of the extremity as Sehrt held at that time.

In his Hunterian Oration[16] reported in the *Lancet* in 1917, Makins for the first time advocated the ligation of the healthy vein when it was necessary to ligate the artery. He states:—

> These considerations and others have led me not only to regard obligatory simultaneous ligation of a main artery and vein as a negligible factor in the risk of gangrene of a limb; but to hold further, that the procedure is preferable whether the vein be injured or not; the result of the combined procedure being to maintain within the limb for a longer period of time the smaller amount of blood supplied by the arte-

rial collateral circulation and hence to improve the conditions necessary for the maintenance of the vitality of the limb.

Following this M. Van Kend[17] reported to the Inter-allied Conference of Surgeons at Paris in May, 1917, the results of animal experiments indicating that the peripheral blood pressure in a limb after the simultaneous ligation of its main artery and vein was greater than after the ligation of the artery alone. He advocated the former procedure, holding that it would raise the residuary blood pressure, and thus provide the most satisfactory conditions for the maintenance of the nutrition of the limb. After discussion at that meeting the following conclusion was adopted:

Contrary to what has until now been believed, simultaneous ligature of both artery and vein when both vessels have been wounded does not give rise to increased risks of gangrene; in fact it diminishes them. Facts tend to prove, even when the wound is limited to the artery, that simultaneous occlusion of the unwounded vein is to be recommended.

Tuffier[18] took up the suggestion and reported his views to the Société de Chirurgie on July 4, 1917:

There is first a fact which appears well demonstrated; it is that ligation of the vein and the artery in the case of wounds of the two vessels does not increase the danger of ischemia. Moreover, the statistics of the English Army, which Sir George Makins has communicated to us, give in this connection the following ratios: Ligation of the artery alone is followed in a general way by gangrene in 40.2 per cent of cases; whereas, simultaneous ligation of the artery and of the vein under the same conditions gives 24.5 per cent, and I speak only of gangrene from ischemia. The most marked difference is in connection with the popliteal; ligation of the artery alone in 6 cases gave favorable results in 58.33 per cent, and gangrene in 41.66 per cent. Simultaneous ligation of the artery and vein has given in 28 cases 22 favorable results, 76.57 per cent, and only 6 cases of gangrene.

(These figures for gangrene appear higher than Makins' figures for the British Army,[10] reported in 1916.)

In Germany also in 1917 Propping[19] seems to have agreed with Sehrt and says:

One sees, therefore, that my explanation of the possible cause of gangrene of a limb after ligation of an artery goes farther than Sehrt's. In place of "the sucking away of the venous blood" I advance the idea of a disproportion between the in and out flow—to a certain extent a disturbance of balance of these two factors—in order to explain the inefficient filling of the capillary bed and the thereby conditioned derangement of the nutrition of the tissues.

Not much more concerning the subject is found in the literature until after the war. Suffice it to say that Makins' influence made this procedure which he advocated almost mandatory in France and England during the late years of the war, according to Halsted.[20] In his book on "Gun-shot Injuries to the Blood Vessels"[21] (1919) Makins sums up the arguments in favor of it without any additions to those previously given.

It must not be supposed that the simultaneous ligation of the artery and vein was not done prior to 1916, although the individually reported cases in the literature are few. Hutchinson[22] reports the case of such a patient operated on by Horne in 1905 in whom the femoral artery and vein were tied for hemorrhage, and gangrene to the knees followed. Another ligation of the femoral artery and vein for aneurysm by Zondek[23] in 1912 was followed by complete recovery. Bernheim and Worth[24] in 1914 reported a case of ligation of the right external iliac artery and vein for aneurysm without gangrene. Cowell[25] ligated the superficial femoral artery and vein for hemorrhage in 1915, and had gangrene of the tips of the toes. Griebel[26] reports a case of ligature of the common iliac artery and vein done by Orth in 1915 with complete recovery of the circulation. Boeckel[27] reports 2 cases of ligature of the femoral artery and vein for aneurysm with no gangrene done in 1916. The point to be observed is that before Makins' advocacy of the procedure

in 1917 the operation was done only in necessity, and with a good deal of temerity and increased fear of gangrene. In fact a perusal of the textbooks shows that every operation for the ligation of a large artery was devised with the thought in mind of preserving the integrity of the main vein, even to the instructions for carrying the ligature around the artery so that the aneurysm needle would point away from the vein.

In regard to the opinion on this subject in our own country after the war, let us turn to that master, and dean of the surgeons of that time, W. S. Halsted, who discussed the matter at length in his treatise on the surgical treatment of aneurysm of the subclavian artery. He reported[20] some experiments carried out on dogs by Hooker in which the blood pressure taken by cannula from the saphenous artery was shown to fall from 114 to 26 mm. Hg after ligation of the external iliac artery, and then to slowly rise in the course of an hour to 50 mm. Hg. At this point successive occlusions of the external iliac vein resulted in rises in pressure of 20, 12, 8, 3, 10 and 14 mm. Hg. The slow rise in pressure noted after the fall following deocclusion of the vein never equalled the level established when the vein was occluded. Then Halsted says:

> Since ligation of the vein raises the blood pressure in the ischemic area, is it not possible that the response of the arterial side for anastomotic development may be delayed or lessened for a period and to a degree conformable to the time and the amount that the vein contributes to the maintenance of the circulation in the extremity? If this is so might not the ligation of the like-named vein be postponed, when this can be done without danger, in order not to relieve the arterial side of its responsibility? Then if after a time there should be evidence of disability from ischemia, such as claudication on exercise, the surgeon would have the ideal opportunity to demonstrate the value of the venous ligation.

Halsted was not at all convinced that gangrene followed aseptic and uncomplicated ligation of the large arteries, for he states:

> It is still believed (Wolff, Matas and others) that ligation of the common iliac artery is followed by gangrene in 33 to 50 per cent of the cases. That this belief is erroneous is proved by my careful study of each reported case. On page 215 of my paper is the following statement. "Granted that in the cases of Lange and Cranwell the ligation of the artery was solely responsible for the gangrene, we have only two such cases in the 30 of my collection, a percentage of six and six-tenths. If it should appear later that Cranwell's case might, for unascertained reasons, be excluded, the percentage would be three and three-tenths, and the sum total of gangrene the cutaneous necrosis of one toe." [And then he goes on further to say]: Gangrene has so rarely followed ligation of the sub-clavian and common iliac arteries that in the case of these vessels, I should for the present be disinclined to tie off simultaneously the corresponding vein.

La Roque[28] in reporting a case of ligation of the external iliac artery and vein for bullet wound of both these vessels done in 1920 is greatly in favor of simultaneous ligation of the vein. After discussing the opinions of others he says:

> The common-sense suggestion occurs that if the blood entering the limb is diminished or cut off entirely, we should at least be sufficiently considerate of the tissues to tie the vein and permit what will of the blood surely containing some food to remain. There is genuine reason for believing that vein ligation favors the development of collateral vessels, and through retention of blood-volume and pressure aids enlargement of vessels already present. [But he also says in two other places in the article]: There is further reason to believe that in the absence of infection, gangrene is never caused solely by ligation of any part of the external iliac or femoral at a point above its communication with the sciatic through the branches of the profunda femoris, [and] if any case of gangrene has ever been conclusively shown to be the result of aseptic ligation solely of the common femoral or external iliac vessels on account of a wound of even moderate recency, the case report is not easily accessible.

Heitz[29] writing in 1923 on blood vessel ligature and suture, advocates simultaneous ligation of the healthy vein.

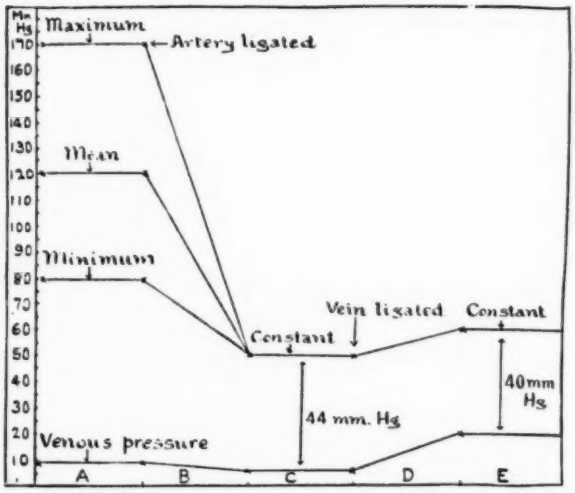

FIG. 1. Changes in pressure in arteries and veins distal to occlusion of primary artery and subsequent occlusion of vein. A, normal maximal, minimal and mean arterial pressures of external iliac artery and normal pressure in common iliac vein; B, effect of ligation of external iliac artery alone on pressure in artery and vein distal to occlusion; it will be noted that pulse pressure completely disappears and intra-arterial pressure falls; there is a slight fall in venous pressure; D, effect of subsequent occlusion of common iliac vein; it will be noted that both arterial and venous pressure rise; arterial pressure rises to point almost as high as minimal pressure in unobstructed artery, and venous pressure higher than normal. (From Brooks and Martin.[30])

So consideration of the clinical literature would seem to indicate:

1. That there was considerable controversy over the incidence of gangrene in limbs following the ligation of one of the main arteries, nearly all surgeons, except Halsted, maintaining that it was very high.

2. That the policy of preserving the accompanying vein whenever this was possible, and the feeling that occlusion of the accompanying vein when this was necessary when ligating the artery increased the danger of gangrene, were completely changed, and in their stead many surgeons were advocating the simultaneous ligation of the healthy accompanying vein as a means of decreasing the incidence of gangrene. Halsted did not concur in this view.

The experimental literature seeks, for the most part, to establish the validity of this procedure on proved physiological grounds.

In 1923 Brooks and Martin[30] published the results of their experimental work on simultaneous occlusion of the iliac artery and vein in animals. Their investigations covered three phases:

1. Changes in temperature of the tissues distal to the ligature. Their results on this phase will be discussed later.

2. Changes in the blood pressure in the veins and arteries distal to the ligatures. In this investigation, determinations were made on 6 large dogs, and a typical chart of the findings is reproduced here (Fig. 1). It will be seen by reference to this chart that while the fall in arterial pressure is great immediately following ligature of the artery as would be expected, the fall in venous pressure is almost negligible. However, after ligation of the vein, the venous pressure rises considerably above normal, and much greater in proportion to the rise in pressure in the artery, decreasing the difference in arterial and venous pressures. This the authors take to mean an increased resistance to outflow of blood from the extremity, and consequently, a decrease in the amount of blood flowing through the extremity. This point should be recalled in reviewing the work of later investigators.

3. The frequency of gangrene after ligation of the artery alone, and of the artery and vein. When the common iliac artery alone was ligated in rabbits, 72.5 per cent of 21 animals developed gangrene. With simultaneous occlusion of the vein 33.3 per cent of 18 animals developed gangrene. It must be said that the percentage of gangrene with ligation of the common iliac alone is much higher than the statistics for man which Halsted puts at 6.6 per cent, and in our own experience with dogs in which we have had no gangrene except in 1 case where the popliteal artery was previously occluded. Their high percentage of gangrene is probably

due to their method of ligation which consisted in ligation of the common and external iliacs just proximal and distal to the origin of the hypogastric thus shutting off the external iliac and the hypogastric at their source, i.e., practically all the blood supply to the limb, which is a much different situation from ligation of the common iliac, or external iliac, or hypogastric individually. This may be due to a peculiarity of the circulation in the rabbit. It does not, however, vitiate the difference found between the results of the two procedures carried out under the same conditions.

The authors concluded that simultaneous ligation of the vein (1) increased the intravascular pressure distally in both veins and arteries; (2) decreased the volume flow of blood; and (3) decreased the incidence of gangrene. They thought that the increased intravascular pressure might bring about a better distribution of blood in the peripheral capillaries, and might aid in the exchange of nutrient substances from within the vessels to the tissues, even though the total volume flow of blood was reduced at the same time, in other words a balance between the arterial and venous systems; and that the simultaneous ligation of the vein would be beneficial or harmful accordingly as the venous obstruction produced would cause to predominate the beneficial effect of elevation of the intravascular pressure, or the harmful effect of the decrease in volume flow of the blood.

In the following year 1924 Brooks in another publication[31] repeats these findings, and concludes with this statement:

> The necessity for ligation of an artery which endangers the viability of an extremity not infrequently arises. The obstruction of the artery throws the burden of supplying an adequate amount of arterial blood for the viability of the extremity on the collateral circulation. The collateral anastomoses increase from day to day. There is therefore a critical period in which the blood supply may be inadequate and gangrene develops before a collateral circulation develops. Our experiments indicate that the risk of gangrene may be decreased by producing a certain amount of venous occlusion at the time the artery is ligated, by ligating the accompanying vein also. This procedure in all probability is beneficial because of the fact that it increases intravascular tension, and thus leads to a more homogeneous distribution of the blood. The ligation of the vein, actually decreases the volume flow of blood. It is important therefore not to produce so much venous obstruction as to decrease the volume flow below that necessary for the life of the extremity. The principle of simultaneous ligation of vein and artery, as first advocated by Sir George Makins is therefore applicable in certain instances, and I believe it should be used if the ligation is at such a point as to endanger the extremity and there is not already present evidence of venous stasis.

In 1925 McNealy[32] taking for his thesis that the clinical and experimental literature showed definite evidence of improved results after simultaneous ligation of vein and artery, attempted to explain these results on purely theoretical grounds with the aid of the literature up to that time. He did not offer any new clinical or experimental evidence in support of his arguments. He favored simultaneous vein ligation, but said that it must be so selected that it would serve only to restore circulatory equilibrium and must not result in too great a drawing back of blood. How this is to be accomplished is not stated. In discussing the work of Brooks and Martin he brought out the following point: "They point out that the simultaneous occlusion of the vein has been thought to bring about a wider distribution of blood. As a result of their experiments they leave one in doubt on that point since their experiments in which the temperature of the tissues was used as a criterion contradict that theory." This criticism is not valid, because the temperature is dependent not on the amount of blood or its distribution, but on the minute volume flow through the limb, which Brooks and Martin declare to be reduced.

In 1925 Harvey and Ferris[33] reported

some interesting temperature determinations from the deep tissues of dogs' feet after ligation of the femoral artery, having

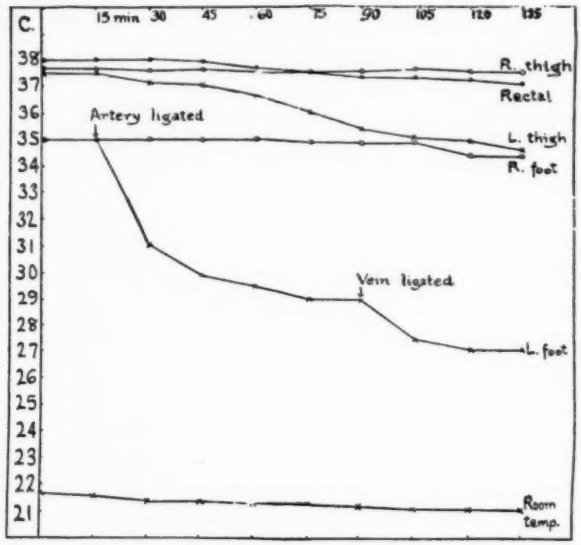

Fig. 2. Temperature changes of extremities following ligation of primary artery of extremity and subsequent ligation of corresponding vein. (From Brooks and Martin.[30])

a bearing on this point. Their curve was constructed from continuous readings from a thermocouple and galvanometer for a period of seventeen hours. The temperature on the ligated side, after a preliminary rise after four hours of observation, fell to almost room temperature during the next eight hours, and then was followed by a sudden rise to normal, thereafter maintained. In the light of these experiments it could be seen that the temperature experiments of Brooks and Martin (Fig. 2) did not tell the whole story as they did not cover a long enough period of time, the longest being six hours. Also the further temperature drop which they attributed to ligation of the vein would come in the period when the temperature of the limb was still falling as a result of ligation of the artery according to the curve of Harvey and Ferris.

Holman and Edwards[34,35] introduced in 1927 what they called a new principle in the surgery of the large vessels, the principle of ligation of the accompanying vein proximal to the site of the ligation of the artery. Their advocacy of this principle was based on three types of experiments:

1. They found that the blood pressure

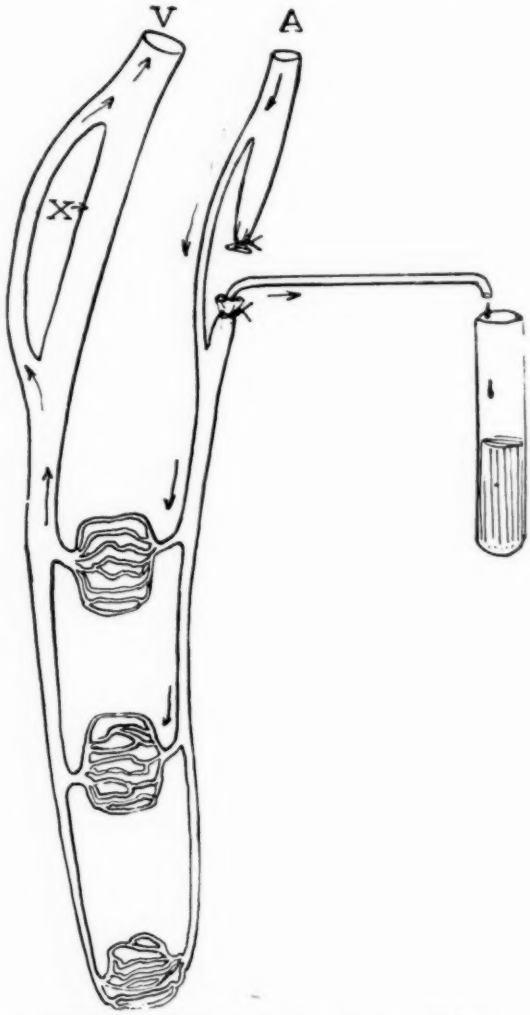

Fig. 3. Experimental method used by Holman to determine effects of ligation of vein on volume flow of blood through extremity. It is obvious that obstruction of vein at X would result in more blood flowing through cannula. The fact that more blood flows from cannula is not an indication of increased volume flow of blood through capillaries, but is evidence for truth of contrary conclusion. (From Brooks.[36])

taken by cannula from the distal end of the divided femoral artery was increased 5 to 10 mm. Hg when the femoral vein was occluded; 14 to 20 mm. Hg when the common iliac vein was occluded, and 24 to 28 mm. Hg with occlusion of the vena cava.

2. The flow from the distal end of the divided femoral artery was taken as a fair index of the volume of blood passing

through the extremity distal to the point of division. This flow was increased 2 c.c. per minute by occlusion of the femoral vein, 10.6 c.c. by occlusion of the common iliac, and 11 c.c. by occlusion of the vena cava.

This experiment is based on the false assumption that the flow from the distal end of the divided artery represents the volume flow of blood through the peripheral portion of the extremity as demonstrated by Brooks[36] in a later paper. While Holman and Edwards consider their experiment as an evidence of increased volume flow through the limb, Brooks shows by a simple diagram (Fig. 3) that obstruction of the vein results in an obstruction of the outflow of blood from the limb and a corresponding increase in the intravascular pressure, and would thus be an evidence of diminished rather than increased volume flow through the peripheral tissues.

3. They ligated the right iliac artery just proximal to the hypogastric, and the vena cava simultaneously 3 cm. above the confluence of the iliac veins in 18 rabbits, and 2 cases of gangrene developed. In 10 other experiments the iliac artery was ligated proximally and distally to the hypogastric, and the vena cava simultaneously proximal to the first large venous tributary, and no gangrene resulted.

Thus, there are 2 cases of gangrene out of 28 animals or a percentage of 7.1. These results they compare with the 33.3 per cent gangrene reported by Brooks and Martin[30] following simultaneous ligation of the vein and artery at the same level. Their conclusions on this angle of the subject would have had more weight if they had run their own series of control animals, ligating the artery alone, as Brooks and Martin did. As a matter of fact, only ten of the experiments done compare in any way with the method of ligation of Brooks and Martin, and there may have been differences in the animals, or technique.

Pearse[37] in 1927 reported results of experiments to determine the advantage of simultaneous ligation of artery and vein versus ligation of artery alone in opposite limbs of the same animal. He found that the residual arterial pressure distal to the ligature when the vein was ligated at the same level was 11 mm. Hg; after one week this had decreased to 8 mm. Hg and after three weeks there was no longer any increase. Though he states in his summary that there was an increased blood volume flow, he does not state the method of measuring this except to say that it was obtained from the femoral artery, and thus it is probably open to the same criticism that Brooks made of Holman and Edwards' method; furthermore, there are no actual readings given in his statement of results on which he bases his conclusions. He found by taking *x*-rays of the injected circulation at various intervals after ligation, that the vascular bed in the limb having the artery and vein ligated was much richer than the limb having only the artery occluded with the maximum difference at the end of two weeks. Brooks[36] had this to say regarding these experiments:

> It is worth while, however, to call attention to the fact that the size of blood vessels as determined by injection is not a reliable index of the actual volume flow of blood through the tissues and also to the fact that the condition of the circulatory bed three weeks after a sudden arterial occlusion is not necessarily important in the study of the cause of gangrene.

To which we may add that variations in the pressure of the injections will modify the results also.

In 1928 Theis[38] reported the results of his experiments on the minute volume flow of blood, and the roentgen appearance of the vascular bed at various intervals after ligation of the artery and vein, as compared with ligation of the artery alone. Ligation of the common iliac vein caused an increase in the volume flow from the distal end of the ligated superficial femoral artery, which, however, was only transient, and the volume flow at the end of one hour

TABLE I

Reported	Operator	Date of Operation	Age	Sex	Indication for Ligation	Artery Ligated	Gangrene Extent		Amputation	
									Day	Location
1 Martin, A. A. *Brit. M. J.*, Jan. 17, 1903.	Martin	Nov. 23, 1901	31	M	Aneurysm of l. ext. iliac	Left comm. iliac	0	0	0	0
2 Maynard, F. P. *Indian M. Gaz.*, p. 253, 1903.	Maynard	Apr. 20, 1903	32	M	Ruptured iliac aneurysm	Rt. com. iliac	0	0	0	0
3 Dreist, K. *Deutsche* Zeit. F. Chir. LXXI: 5, 1904.	Czerny	Feb. 26, 1897	28	M	Slight hem. in course of operation	Left comm. iliac	0	0	0	0
4 Dreist, K. *Deutsche Ztschr. Chir*, 71: 5, 1904.	Trendelenburg	Oct. 4, 1898	60	M	Dissecting aneurysm of comm. iliac	Left comm. iliac	0	0	0	0
5 Dreist, K. *Ibid.*	Von Christel	Mar. 6, 1901	28	M	Hem. foreign body around femoral	Left comm. iliac	+	Upper and mid. ⅓ of leg	+	Upper leg
6 Dreist, K. *Ibid.*	Ernst Kuster	Jan. 7, 1898	17	F	Elephantiasis	Rt. femoral	0	0	0	0
	Ernst Kuster	Mar. 18, 1898	17	F	Elephantiasis	Rt. ext. iliac	0	0	0	0
(Same patient)	Ernst Kuster	Jan. 26, 1898	17	F	Elephantiasis	Left femoral	0	0	0	0
	Ernst Kuster	Jun. 23, 1898	17	F	Elephantiasis	Left comm. iliac	0	0	0	0
7 Hickson, L. *J. Roy. Army M. Corps*, 2: 23, 1904.	Hickson	July 17, 1900	40	M	Fem. art. vein aneurysm Hunter's canal	Fem. art. & vein quad. lig. & excision	0	0	0	0
8 Hickson, L. *Ibid.*	Hickson	May 12, 1900	32	M	False aneur. bullet wound	Sup. fem. lig. above & below excision	0	0	0	0
9 Hickson, L. *Ibid.*		Nov. 10, 1900	30	M	Hem. for bullet wound of sup. fem.	Fem. art. in Scarpa's Δ	+	Foot deep ulcers of leg	+	Mid-thigh
10 Hickson, L. *Ibid.*	Hickson	Mar. 28, 1902	?	M	False aneur. bullet wound of fem.	Sup. fem. at base of Scarpa's Δ	0	0	0	0
11 Isambert & Petit. *Arch. de med. & pharm. Mil.*, 43: 121, 1904.	Isambert	Feb. 6, 1903	30	M	Aneyrysm following knife wound	Fem. above & below wound & the profunda	0	0	0	0
12 Smith, A. C. *J. A. M. A.*, 43: 813, 1904.	A. C. Smith	June 24, 1904	30	M	Aneurysm of rt. common fem.	Rt. external iliac	0	0	0	0
13 Clark, H. G. *Brit. M. J.*, p. 850, 1905.	Clark	May 20, 1905	26	M	Knife wound of profunda 25 days?	Left common iliac	0	0	0	0
14 Cranwell, D. J. *Rev. soc. med. argen.*, 14: 338, 1906.	Cranwell	Feb. 28, 1904	48	M	Aneur. of iliac & fem. arts.	Rt. comm. iliac	+	Mid ⅓ of 2nd leg	+ 2nd	Mid-thigh
15 Rustin, F. *West. Med. Rev.*, 11: 184, 1906.	Rustin	Apr. 22, 1906	Adult	M	Poplital aneurysm	Sup. fem. 2 in. below profunda	0	0	0	0
16 Guinard, A. *Bull. & mem. Soc. de Chir. de* Paris, 32: 999, 1906.	Guinard	Oct. 9, 1906	17	M	Hemorrhage from knife wound	Fem. art. & vein Mid-thigh	+ 40th day	"Muscl. Jambier anterieur"	0	0
17 Hutchinson, J. *Lancet*, 1: 1388, 1906.	Horne	Sept. 1 1905	22	M	Knife wound of femoral art. & vein	Common femoral and vein	+ 15th day	upper part of patella	15th	Mid-thigh
18 Nydegger, J. A. *Ann. Surg.*, 44: 96, 1906.	Nydegger	N.S.	52	M	Aneurysm in groin	Left external iliac	0	0	0	

TABLE 1 (*Continued*)

Death		Complications	Collateral Circulation Indications	Remarks
Day	Cause			
0	0	Large aneurysm of external iliac	Wrapped in cotton wool and bandaged 3 days after operation left leg still colder; no feeling, blanched, toes edematous. No pulse	One week later after operation temperature of both feet nearly same. 2½ months later was O.K.
6th	Diarrhea and vomiting	Large iliac aneurysm, ruptured; diarrhea; bronchitis	"Circulation of extremities not manifestly affected by operation"	No post mortem
5 mos.	Acute miliary Tbc.	Small branch torn off during operation for tuberculous lymph glands	"Left extremity somewhat cold during first two days"	
3 hrs.	Hemorrhage	Wretched general condition		
0	0	Emaciated, anemic. External iliac ligated above & below epigastric	"Aftera time leg became cold and insensible"	
0	0	None	Limb became paler after operation	
0	0	Rt. femoral previously ligated	No observations	
0	0	Rt. femoral previously ligated	No observations	
0	0	Left femoral previously ligated	Limb cooler toward eveing. Temperature of both legs same on 4th day	
0	0	Artery-vein aneurysm—4 months' duration	"There was neither loss of temperature in the limb nor edema"	Complete recovery
0	0	False aneurysm—1 month	"There was never any loss of heat in the leg after operation	Complete recovery
0	0	Large effusion of blood into tissues of thigh	At first collateral circulation appeared well established. "Gangrene no doubt resulted from pressure exerted by fibrous clots on the collateral circulation	
0	0	Large clots in tissues of thigh (removed at operation)	"Patient made an uninterrupted recovery"	
0	0	Aneurysm—3 weeks	No trouble in the leg below the ligature	
0	0		Natural temperature restored the following morning. Leg swathed in cotton & bandages & hot water bottles	Leg swathed in cottonand bandages and hot water bottles
0	0	Infection. Repeated hemorrhage. Profunda and common femoral previously ligated	No immediate observations	
0	0	Popliteal aneurysm—4 months duration	Application of heat to leg slightly above body temperature. 24 hrs. after operation the foot was comparatively cool, and remained that way for 3 days	
36th	Arteriosclerosis; sacral decubitus, gangrene	General arteriosclerosis. Great edema of thigh and legs	Next day leg was livid and without sensation, calf to toes	
0	0	Exsanguinated	The next day did not observe anything wrong with foot or leg which was kept wrapped in cotton	The gangrenous muscle of the lower leg was removed entirely and recovery followed
0	0	Pulseless from hemorrhage. Artery & vein severed; both tied	Discoloration to 3 in. below knee noted on 3rd day	
0	0		At first there was noticeable discoloration which gradually disappeared. Leg surrounded by cotton & hot water bottles for 2 days	Leg surrounded by cotton and hot water bottles for 2 days

TABLE I (*Continued*)

Reported	Operator	Date of Operation	Age	Sex	Indication for Ligation	Artery Ligated	Gangrene Extent		Amputation	
									Day	Location
19 Gillette, W. D. *Ann. Surg.*, 38: 22, 1908.	Gillette	Apr. 18, 1906	56	M	Aneurysm of left sciatic art.	Left common iliac near aorta	+	Upper and mid ⅓ of leg	6th	Mid-thigh
20 Westbrook, R. W. *L. I. Med. J.* 2: 237, 1908.	Westbrook		24	M	Punct. wound during herniotomy	Ext. iliac-deep epigastric-deep circumflex iliac	0	0	0	0
21 Moschowitz, A. V. *Ann. Surg.*, 48: 872, 1908.	Moschowitz	July 27, 1907	36	M	Hemorrhage caused by drainage tubes	Both ext. iliacs	0	0	0	0
22 Paddison, J. R. *Charlotte M. J.*, 58: 253, 1908.	Paddison & Babinson	Dec. 18, 1907	20	M	Wound by dynamite cap	Rt. fem. 2¼ in. below Poupart's	0	0	0	0
23 Lanphear, E. Am. J. Surg, 23: 180, 1909.	Lanphear		N.S.	N.S.	Oozing from malignant mass at Scarpa's Δ	Rt. common iliac	0	0	0	0
24 Godkin, L. R. *J. Roy. Army M. Corps*, 17: 165, 1911.	Godkin	Sept. 15, 1910	31	M	Aneurysm left comm. fem.	Left external iliac	0	0	0	0
25 Halsted, W. L. *Johns Hopkins Hosp. Bull.*, 23: 191,1904.	Halsted	Jan. 11, 1909	44	M	Aneurysm left ext. iliac	Left comm. iliac	0	0	0	0
26 Zandek. *Berl. klin. Wchnschr.*, 49: 559, 1912.	Zandek		27	M	Femoral A-V. aneurysm	Fem. art. & vein	0	0	0	0
27 Bernheim, B. M. *Ann. Surg.*, 59: 558, 1914.	Bernheim		7	M	Rt. ext. iliac A-V. aneurysm	Rt. ext. iliac art. and vein	0	0	0	0
28 Darling, C. G. *J. Mich. M. Soc.*, 13: 46, 1914.	Darling		20	M	Wound by explosive missile	Left external iliac	0	0	0	0
29 Darling, C. G. *Ibid.*	Darling	1898	16	M	A-V. aneurysm 5 yrs.	Rt. superficial fem.	0	0	0	0
30 Orth, O. *Arch. f. Klin. Chir.*, 106: 823, 1915.	Orth		22	M	Bullet wound	Rt. common iliac—Art. & vein	0	0	0	0
31 Fee, F. *Lancet-Clinic, Cincin.*, 113: 594, 1915.	Fee		48	M	Aneurysm of rt. ext. iliac	Rt. common iliac art.	0	0	0	0
32 Boeckel. *Bull. Acad. de Med. Paris*, 76: 239, 1916.	Boeckel	May 21, 1916		M	A-V. aneurysm —2 mos. duration	Femoral art. & vein	0	0	0	0
33 Boeckel. *Ibid.*	Boeckel	Aug 22, 1916		M	A-V. aneurysm 3 mos. duration	Femoral artery & vein	0	0	0	0
34 Masnata, G. *Gazz. d. osp.*, 37: 1027 1918,	Field Surgeon	June 20, 1916	Adult	M	Prim. hemorr. Grenade wound	Fem. at base of Scarpa's Δ	+ 1	Gas gangrene	0	0
35 Pybus, F. C. *Edinburgh M. J.*, 19: 109, 1917.	Pybus	June 14, 1916		M	False aneurysm of fem. art.	Rt. superficial fem.	0	0	0	0
36 Pybus, F. C. *Ibid.*	Pybus	Aug. 9, 1916	25	M	Perforating wound	Femoral art. & vein	0	0	0	0
37 McClay, N. *Edinburgh M. J.*, 19: 112, 1917.	Morison	Feb. 2, 1917	36	M	Sec. hemorr. & aneurysm of ext. iliac	External iliac	0	0	0	0
38 Cowell, E. M. *Brit. M. J.*, 1: 577, 1917.	Cowell	Dec. 13, 1915		M	Wound through thigh	Superficial fem. art. and vein. Quadruple lig.	0	0	0	0
39 Cowell, E. M. *Ibid.*	Cowell	Jan. 3, 1917		M	Wound through thigh	Superficial femoral artery and vein. Quadruple lig.	+	Tips of toes (3 weeks)	0	0
40 Stillwell D. L. *J. Mich. M. Soc.*, 17: 296, 1918.	Stillwell	July 18, 1917	23	M	Hemorr. from explosion wound	Fem. art. severed ½ in. below Poupart's	0	0	0	0
41 Sertorio, M. *Policlinico*, 25: 227, 1918.	Sertorio	Dec. 11, 1916	Adult	M	Sec. hemorrhage (?) fract.-infection	Left comm. fem.	0	0	0	

TABLE 1 (*Continued*)

Death		Complications	Collateral Circulation Indications	Remarks
Day	Cause			
0	0	Left internal iliac ligated 7 months previous, Aneurysm left. Sciatic—Left external iliac ligated at same operation	No statements	
0	0	Deep epigastric and deep circumflex iliac ligated at same time	Discomfort & numbness in leg. No immediate observation. Cotton & hot water bottles for several days	Cotton and hot water bottles for several days
0	0	Infected wounds	Evening of same day toes were warm and pink; next day slight femoral pulsation. 3rd day D.P. pulse palpble	
0	0	Hemorrhage from wound	Limb kept warm with hot water bottles. No other observations	
30 hrs.	Postop. shock	Oozing from malignant mass at Scarpa's Δ. Another large vessel coming from lumbar region was lig. tumor removed	24 hrs. postoperative right leg was mottled and cold from toes to hip	This case apparently not included in Halsted's series
0	0	Aneurysm of left common femoral	Limb wrapped in cotton wool and blanket. Feeble post tibial pulse 8th day	
0	0	Large aneurysm of left external iliac	After operation left foot seemed cooler than right, but was of good color and no impairment of sensation. At midnight slight bluish tinge to skin lasting 2 hours	
0	0	Quadruple ligature of femoral artery & vein	Immediately leg seemed blanched. 4 hrs. later had sensation of tingling and feeble capillary circulation under nails	
0	0	Quadruple ligature above and below aneurysm	"Rapid, uneventful recovery." Has no right femoral or popliteal pulse, but has D.P. pulse	
0	0	Hemorrhage from wound 8th day. Ligated above only	Collateral circulation established previous to ligature. Uneventful recovery	
0	0	Artery & vein ligated above and below and sac excised	Leg elevated and surrounded with cotton. No difficulty	
4 mos.	Pulmonary tuberculosis	Ligated above and below a bullet wound	No immediate observations	
0	0	Aneurysm of rt external iliac. 7 yrs. duration	"Satisfactory recovery"	
0	0	Quadruple ligature with extirpation of intervening segments	No immediate observations. Ultimate recovery	
0	0	Quadruple ligature with extirpation of intervening segments. Both for femoral A-V aneurysm	No immediate observations. Ultimate recovery	
32 hrs.	Gas gangrene	Hemorrhage from grenade wound	The whole right leg was white, gelatinous, insensible	
0	0	False aneurysm of lower femoral from wound 10 days previous	No immediate observation on circulation of limb. Complete recovery	
0	0	Quadruple ligature of artery and vein with resection. Infected wound	No immediate observations. Ultimate recovery.	
0	0	2nd operation Feb. 13, to pack aneurysmal sac 3rd operation Feb. 16, ligature of deep epigastric artery and vein	Feb. 3 leg quite warm, slightly pale. Feb. 17 good, March 16 good. June 4, no difference in legs.	
0	0	War wound. Patient almost dead	"Foot in critical state for 2 days, then circulation improved"	
0	0	War wound. Thigh swollen. Foot cold	Circulation returned in a few hours. Condition of foot never doubtful	
0	0	Hemorrhage and shock	End of operation leg was cold and cyanotic. Warm H_2O bottles. 7 hours leg warmer and better color. Next day, warm and of good color. Recovery	
0	0	Second hemorrhage complicated fracture 25 day previous. Osteomyelitis	"The leg remained always warm"	

TABLE 1 (*Continued*)

Reported	Operator	Date of Operation	Age	Sex	Indication for Ligation	Artery Ligated	Gangrene	Extent	Amputation Day	Amputation Location
42 Sertorio, M. *Ibid.*	Sertorio		Adult	M	Prim. hemorr. of post. tibial vessels	Rt. sup. fem. in Hunter's canal	0	0	0	0
43 Davidson, C. F. *J. A. M. A.*, 73: 269, 1919.	Davidson	Feb. 22, 1919	15	M	Puncture wound	External iliac	0	0	0	0
44 Davidson, C. F. *Ibid.*	Bergman			M	Traumatic aneurysm of femoral	External iliac	0	0	0	0
45 Greibel, E. *Deutsch Ztschr. Chir.*, 155: 312, 1920.		1915			Aneurysm of comm. iliac	Common iliac	0	0	0	0
46 Fallis, W. E. *Kentucky M. J.*, 19: 281, 1921	Fallis	1920	17	M	Sec. hemor. bullet wound in art.	Fem. art. above & below wound	0	0	0	0
47 Bell, G. *M. J. Australia*, 1: 189, 1921.	Bell	July 14, 1920	15	M	Wound	Left comm. fem. art.	0	0	0	0
48 Ellars, L. R., Am J. Surg., 35: 214, 1921.	Ellars	April 1, 1920	20	M	Wound	Left common fem.	0	0	0	0
49 LaRoque, G. P. *Ann. Surg.*, 63: 265, 1921.	LaRoque	Aug. 25, 1920	22	M	Gunshot wound	Ext. iliac art. & vein	+	Plantar surface of 3 toes	0	0
50 Priest, J. *Missouri M. A.*, 18: 463, 1921	Brooks	May 10, 1921	40	F	Aneurysm of ext. iliac	Rt comm iliac	0	0	0	0
51 La Roque, G. P. *Ann. Surg.*, 75: 705, 1922.	LaRoque		25	F	Gunshot wound	Fem. below profunda & vein	0	0	0	0
52 Dodd, J. M. *J. A. M. A.*, 79: 1245, 1922.	Dodd		25	M	Metal rod wound. Hemorrhage	Femoral	0	0	0	0
53 Grover, C. P., & Fisher, D *Ann. Surg.*, 78: 84. 1923.	Grover	June 27, 1922	29	M	Femoral A-V. aneurysm	Femoral artery & vein	0	0	0	0
54 Hansen, R. N. *Acta Chir. Scandinav.*, 58: 405, 1925.	Hansen		27	F	Bilat femoral aneurysm	2 ext. iliac bilat.	0	0	0	0
55 Hansen. R. N. *Ibid.*	Hansen		23	M	Hemorrhage from bullet wound	Femoral (lower) art.	0	0	0	0
56 Hansen, R. N. *Ibid.*	Hansen		20	M	Hemorrhage from thigh wound	Femoral art.	0	0	0	0
57 Thompson, J. E. *Texas State M. J.*, 21: 15, 1925.	Thompson	Aug. 16, 1915	30	M	Aneurysm of l. comm. iliac	Left common iliac	0	0	0	0
58 Thompson, J. E. *Ibid.*	Singleton	Sept 21, 1922	27	M	Aneurysm of l. ext. iliac	Left comm iliac	0	0	0	0
Thompson, J. E. *Ibid.*	Thompson	Sept. 21, 1922	27	M	Aneurysm of left internal iliac	Left femoral above profunda	0	0	0	0
59 Haggard, W. D. *Texas State M. J.*, 21: 21, 1925.	Floyd		30	M	A-V. aneurysm of ext. iliac	Rt ext. iliac art. & vein	0	0	0	0
60 Lewis, Dean & Reichert, F. L. *J. A. M. A.*, 87: 5: 302, 1926.	Lewis	Apr. 10, 1926	67	M	Thromboangiitis obliterans	Rt. femoral below profunda	0	0	0	0
61 Neill, T. E. *Ann. Surg.*, 86: 425, 1927.	Neill	Oct. 25, 1926	59	M	Endarteritis obliterans with gangrene	Femoral below profunda	+	of toes present before operation	0	0
62 Junken, H. D. *Northwest. Med.*, 26: 36, 1927.	Junken	Apr. 25, 1925	12		Bullet wound	Rt. comm. fem. art. & vein	0	0	0	0
63 Barbier, Guilleminet & Pouzet. *Lyon med.*, 139: 236, 1927.	M. Berard	June 23, 1926	16	M	Subcutaneous rupture	Rt. ext. iliac	0	0	0	0
64 Bessesen, A. N. Jr., Bessesen, D. H. *M. J. & Rec.*, 127: 547, 1928.	Bessesen		23	F	Hemorrhage abdom. pregnancy	Left common iliac	0	0	0	0

TABLE I (*Continued*)

Death		Complications	Collateral Circulation Indications	Remarks
Day	Cause			
0	0	Hemmhorage from laceration and contusion post. tibial vessels	"This case showed no appreciable disturbance of nutrition, sensibility or movement	
0	0	Patient in precarious condition from hemorrhage	Immediately leg became purple and enlarged. In 2 hours, 10 minutes, pulse of post-tibial felt. Leg normal color and size in few hours	
0	0		"Collateral circulation established in one hour and 10 minutes	
+?	Perforated duodenal ulcer	Aneurysm and hole in common iliac size of penny. Common iliac resected between 2 ligatures	Pulse appeared in femoral artery after removal of aortic clamp	Wound became infected
0	0	Hemorrhage	After 24 hours pulse at ankle and color of toes reestablished, though foot colder than other for 6 or 7 days	
0	0	1.9 cm. artery resected between two ligatures	No coldness, nor signs of failure of circulation. No post-tibial pulse Aug. 15, 1920. Well marked pulse Nov. 3, 1920	Wound in vein closed by lateral ligature
0	0	Gunshot wound. Shock	No immediate observations	Leg wrapped in cotton. Later ischemic myositis cured by tenotomy
0	0	Immediate operation Quadruple ligature with excision	Next day foot and limb sweating. No pulse 16 weeks later	Leg wrapped in cotton and surrounded by heat
0	0	Aneurysm of external iliac, 6 years duration	Pulsation in sac returned before patient left table. No other observations	
0	0	Quadruple ligature with resection	No immediate observations. No palpable pulse in 3 weeks, otherwise normal	Leg surrounded with abundance of heat
0	0	Hemorrhage 6 days after thigh wound. Excision between ligatures	Kept warm. "Sufficient collateral circulation to sustain its vitality"	
0	0	Quadruple ligature of artery & vein with resection	No immediate observations. 3 weeks later, no peripheral pulses, but leg appeared normal	Authors recommend simultaneous artery & vein ligature
2½ mos.	Operation on abdominal aneur.	Spontaneous bilateral femoral aneurysm. Severe heart disease	After operation legs warm and appeared normal to sight and touch	
0	0	12 days after bullet wound. Lateral ligature of vein. Ligature of artery above & below wound just above popliteal	No immediate observations. Pulse in popliteal and tibial artery weaker than other side. Leg otherwise normal	
0	0	Hemorrhage. Ligature above and below thigh wound. Sharp instrument	No immediate observations. Two days later anterior tibial pulse felt, but feebler than other side	Complete recovery
1 yr.	Recurrent aneurysm	Large common iliac aneurysm	No immediate observations. Few days later sac begun to pulsate and in 2 weeks pulsated strongly as before ligature	
0	0	Aneurysm of left external iliac	No immediate observations. "Circulation in thigh and leg good at end of 1 month"	
0	0	Aneurysm of left external iliac bleeding from puncture of the sac	Circulation in leg never embarrassed at any period	
0	0	Aneurysm. Ligated above and below	"Uneventful recovery"	
0	0	Thrombo-angitis obliterans with pain and ulcer of right heel	"No signs of gangrene followed ligature of artery"	
36th	Sudden death. Pulm. embolus?	Endarteritis obliterans with necrosis of distal phalanges of toes	Steady improvement in circulation and subsidence of gangrene	
0	0	Bullet wound. Shock. Typhoid on 25th day	Immediately extremity was cold, mottled, and had less sensation. Radiant heat applied	
0	0	Subcutaneous rupture. Operation 20 hours after accident	Foot white and cold for one week, gradually lessening. No pulses in foot 4 mos. later	
0	0	Pulseless from hemorrhage from abdominal pregnancy	Left leg numb for while. 2 mos. later attended dances	

TABLE II

		Gangrene									Amputation								Death								Total Ligations
Age		1–10	11–20	21–30	31–40	41–50	51–60	Over 60	Not Stated.*	Total	1–10	11–20	21–30	31–40	41–50	51–60	Over 60	Not Stated	Total	1–10	11–20	21–30	31–40	41–50	51–60	Over 60	Not Stated	Total	
Common iliac	Male	0	0	1	0	1	1	0	0	3	0	0	1	0	1	1	0	0	3	0	0	1	1	1	2	0	2	7	17
	Female	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Common iliac artery & vein	Male	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
	Female	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
External iliac artery	Male	0	0	0	0	0	0	0	0	00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
	Female	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1*	0	0	0	0	1	1	
External iliac artery & vein	Male	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
	Female	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Common femoral artery	Male	0	1	1	0	0	0	0	1	3	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	12
	Female	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Common femoral artery & vein	Male	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
	Female	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Superficial femoral artery	Male	0	0	0	0	0	1†	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	10
	Female	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Superficial femoral artery & vein	Male	0	1	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
	Female	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		0	2	3	0	1	2	0	2	10	0	0	3	0	1	1	0	0	5	0	0	3	1	1	3	0	3	11	69

* Bilateral ligation
† Present before ligation

was not any greater than when the artery alone was ligated. The volume flow from the distal end of the ligated artery does not represent the minute volume flow through the periphery of the limb, as previously pointed out in regard to Holman and Edwards' work. At the same time even with this method he failed to confirm Holman's findings. In direct contradiction to Pearse's roentgen findings, Theis found that the vascular bed was better immediately after ligation of the vein and artery, but that three weeks later the vascular bed was more developed were the artery alone was ligated.

Brooks[36] in 1929 summed up the situation in this manner:

(1) All observers agree that ligation of the concomitant vein in the presence of simple arterial obstruction raises the blood pressure in both the veins and the arteries distal to the obstruction. (2) Both experimental and clinical experience indicates that the incidence of gangrene is diminished. (3) In the attempts to explain the beneficial effects of therapeutic venous occlusion without arteriovenous fistula is found the confusion of ideas.

He then expresses his views on the difference in therapeutic venous obstruction as applied to the treatment of arteriovenous fistula, and to simple arterial obstruction. His own clinical experience leads him to believe that venous occlusion of an amount sufficient to be of value in the prevention of gangrene is often followed by manifestations of venous stasis from which convalescence is prolonged or incomplete. He concludes that simultaneous ligation of the vein is not to be considered the preferable procedure in all arterial ligations. It is to be applied only in those in which without ligation of the vein gangrene would be expected. He thinks simultaneous vein ligation is indicated in ligation of the popliteal or axillary arteries; that it makes little or no difference in ligature

TABLE III
INDICATIONS FOR LIGATION

	Arterio-venous Aneurysm	Aneurysm	Hemorrhage	Elephantiasis	Malignancy	Hemorrhage Abdominal Pregnancy	Obliterative Endarteritis	Total
Common iliac	0	11	3	1	1	1	0	17
Common iliac artery & vein	0	0	1	0	0	0	0	1
External iliac	0	7	2	1	0	0	0	14
External iliac & vein	2	0	1	0	0	0	0	3
Common femoral	0	1	9	2	0	0	0	12
Common femoral & vein	5	0	3	0	0	0	0	8
Superficial femoral	1	4	3	0	0	0	2	10
Superficial femoral & vein	0	0	4	0	0	0	0	4
	8	23	30	4	1	1	2	69

Number of cases—64
Number of ligations—69

TABLE IV
GANGRENE CASES

Case No.	Operator	Artery Ligated	Age	Sex	Indications	Complications	Amount of Gangrene	Amputation
14	Cranwell	Right common iliac	48	M	Aneurysm of iliac & femoral arteries	General arteriosclerosis. Great edema of thigh and leg	Mid ⅓ of leg	+
5	Von Christel	Left common iliac	28	M	Hemorrhage from foreign body wound of femoral	Emaciated, anemic. Iliac ligated above & below epigastric	Junction upper and mid ⅓ of leg	+
19	Gillette	Left common iliac	56	M	Aneurysm of left sciatic artery	Left internal iliac ligated. 7 months previous. Left external iliac ligated at same time	Junction upper and mid ⅓ of leg	+
34	Masnata	Common femoral	Adult	M	Primary hemorrhage grenade wound	Hemorrhage from grenade wound	Whole leg. Gas gangrene	Died
9	Hickson	Common femoral	30	M	Primary bullet wound. Superficial femoral	Large effusion of blood into thigh tissues	Foot. Deep ulcers of leg	+
16	Guinard	Superficial femoral	17	M	Primary hemorrhage knife wound	Exsanguinated	Anterior leg muscle only	0
61	Neill	Superficial femoral	59	M	Obliterative endarteritis with gangrene	Obliterative endarteritis	Necrosis of toes present before operation	0
48	Ellars	Common femoral	20	M	Gunshot wound	Gunshot wound, shock, hemorrhage	Plantar surface of 3 toes	0
39	Cowell	Superficial femoral artery and vein	Adult	M	Wound through thigh	Gunshot wound. Patient almost dead	Tips of toes	0
16	Hutchinson	Common femoral artery and vein	22	M	Hemorrhage from knife wound of femoral artery and vein	Pulseless from hemorrhage	Upper part of patella	+

TABLE V
DEATH CASES

Case No.	Operator	Artery Ligated	Age	Sex	Indications	Complications	Time of Death	Cause of Death
23	Lanphear	Right common iliac	N.S.	N.S.	Oozing from malignant mass	Oozing from malignant mass at Scarpa's triangle. Another large vessel coming from lumbar region was ligated. Tumor removed	30 hours	Postoperative shock
45	Greibel	Common iliac	..	..	Aneurysm of common iliac	Aneurysm and hole in common iliac size of penny. Resected between 2 ligatures		Perforated duodenal ulcer
54	Hansen	External iliac	27	F	Spontaneous bilateral aneurysm of femoral arteries	Severe heart disease	2½ months	Operation on abdomen. Aneurysm
61	Neill	Superficial femoral	59	M		Obliterative endarteritis with gangrene	36 days	Sudden death. Pulmonary embolus
57	Thompson	Left common iliac	54	M		Large common iliac aneurysm	1 year	Recurrent aneurysm
30	Orth	Common iliac artery and vein	22	M	Bullet wound	Ligated above and below bullet wound	4 months	Pulmonary tuberculosis
34	Masnata	Common femoral	Adult	M	Hemorrhage. Grenade wound	Hemorrhage from grenade wound	32 hours	Gas gangrene
2	Maynard	Common iliac	32	M	Ruptured iliac aneurysm	Large iliac aneurysm ruptured, diarrhea, bronchitis	6 days	Diarrhea and vomiting
3	Czerny	Common iliac	28	M	Slight hemorrhage in course of operation	Slight hemorrhage from small branch torn off during operation for tuberculosis gland	5 months	Acute miliary tuberculosis
4	Trendelenburg	Common iliac	60	M	Dissecting aneurysm of common iliac	Wretched general condition	3 hours	Hemorrhage
14	Cranwell	Common iliac	48	M	Aneurysm of iliac and femoral arteries	General arteriosclerosis. Great edema of thigh and leg	36 days	Arteriosclerosis, sacral decubitus, gangrene, amputation

of the femoral or brachial arteries; and that in ligating the common femoral artery it is wiser to leave the accompanying vein unoccluded unless signs of impending gangrene develop later.

In order to obtain some idea of the results following ligation of the large arteries of the lower extremity in man, a careful compilation was made of all the individually reported cases of ligation of the common and external iliac, and common and superficial femoral arteries in the literature from 1900 to January 1930. (Table I.) This did not include statistics of groups of cases reported without individual data as to complications, amount of gangrene, or cause of death. The significant data from this study have been condensed into 4 tables. There was found a total of 69 ligations performed in 64 cases (some were bilateral). Table II shows the age incidence for each of the arteries ligated. Table III shows the indications for ligation. In Table IV the 10 cases of the group that developed

gangrene are analyzed. The incidence of gangrene in the 69 ligations was 10 cases, or 14.4 per cent. In some of these the account of other complications which might influence the occurrence of gangrene, the percentage would more nearly approach

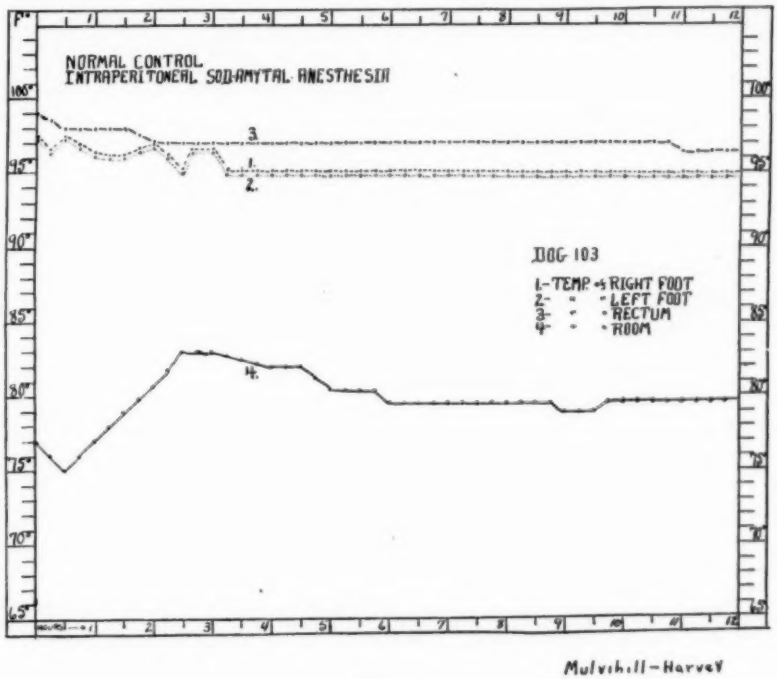

Fig. 4.

amount of gangrene was very small, and in Neill's case of obliterative endarteritis, necrosis of the toes was already present before the ligation. Only 5 cases or 7.7 per cent of 69 ligations required subsequent amputation. Death followed in 11 cases, or 15.9 per cent of 69 ligations as shown in Table v. In 4 of these cases the deaths occurred from five months to more than a year after the ligation, and from causes not directly connected with the operation. In 1 case death two and one-half months later followed a second operation on an abdominal aneurysm. Therefore, the number of deaths which might be considered to be due directly or indirectly to the ligation are reduced to 6, or 8.69 per cent.

This study of the literature would seem to indicate that the incidence of gangrene following ligation of the large arteries of the lower limb in man is not as high as generally supposed. The total incidence of gangrene in this collection of cases is 14.4 per cent, and if cases were excluded on the 6.6 per cent given by Halsted[39] as the incidence of gangrene in ligations of the common iliac artery.

METHOD

Our own experiments consist of temperature measurements in the deep tissues of the periphery of limbs of dogs. The temperatures were taken continuously by means of thermocouples inserted in the central footpads of both feet, and into the rectum, and another exposed to room temperature, and recorded on an automatic recording potentiometer as previously described by us.[1] This instrument automatically prints a temperature reading from each of the 4 thermocouples every four minutes, and from these readings the graphs are constructed. The instrument is accurate to within 0.5° F.

For the experiments seven dogs were used. For anesthesia amytal was found to be most satisfactory in previous experiments in this laboratory. This is prepared

in 10 per cent solution in half-normal sodium hydroxide, according to the directions given by the manufacturer. Injections were given intraperitoneally in dosage of 55 mg. per kilogram of body weight. The animals were usually under anesthesia within ten minutes after the administration of the drug, and remained under complete anesthesia throughout the duration of the experiment with little, if any, effect on the temperature of the body or extremities, as is shown by the control (Fig. 4).

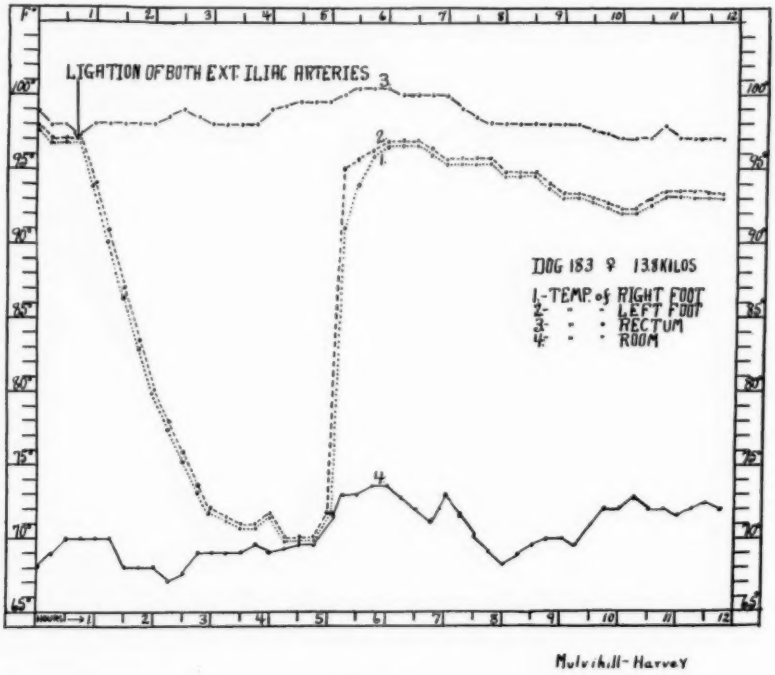

Fig. 5.

After a sufficient time had elapsed to obtain normal readings, we proceeded with the ligation of the arteries and veins. The operative procedure was the same in all animals. An incision 2 in. long was made through the skin and superficial tissues along the external border of the rectus muscle. The edge of the rectus muscle was retracted medialward, and the peritoneum pushed toward the midline, exposing the external iliac artery above the first large branch (the inferior epigastric). The sheath of the artery was split longitudinally for a distance of 1.5 cm. and a double silk ligature passed around the artery by means of an aneurysm needle and tied tightly. The accompanying vein was then ligated at the same level. The tissues were then allowed to fall back into place, and approximated with two layers of No. 0 catgut, and the skin closed with subcutaneous suture of black silk. Great care was taken to preserve the small vessels and nerve filaments accompanying the large artery and vein. The procedure on the opposite side was the same except that the vein was not ligated. It should be noted that in the dog both the external and internal iliac arteries arise from the root of the aorta, there being no common iliac artery as in man.

This series of experiments is a continuation of our previously published series[1] of results following ligation of the femoral, and external iliac arteries. A typical curve showing the temperature changes, and reestablishment of collateral circulation after ligation of the external iliac artery is included here for comparison (Fig. 5).

In order to conserve space, we are including only one typical curve of the experimental results. The graphs of results of

similar procedures on all the other six dogs were practically the same. The curve (Fig. 6) shows that after ligation of the

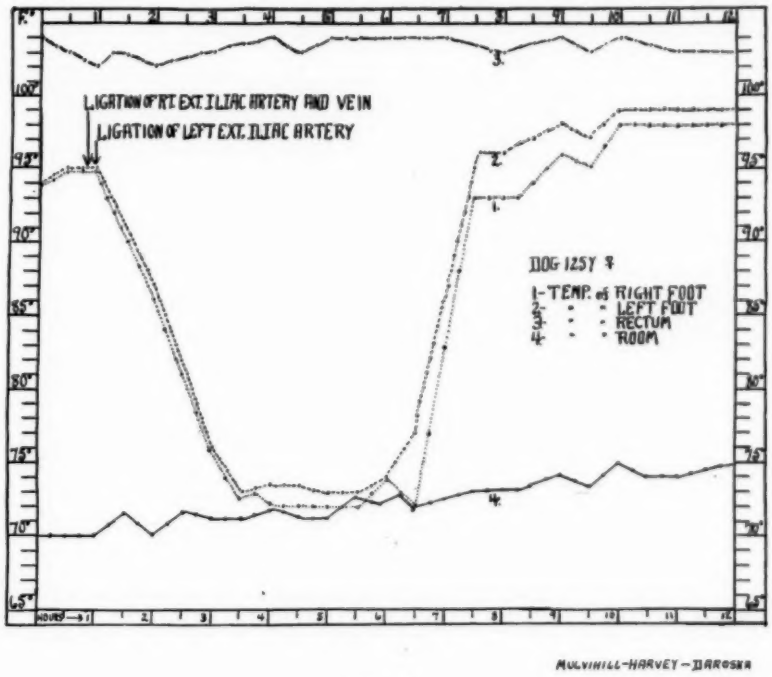
LIGATION OF RT. EXT. ILIAC ARTERY AND VEIN
LIGATION OF LEFT EXT. ILIAC ARTERY
DOG 1257 ♀
1- TEMP. of RIGHT FOOT
2- " " LEFT FOOT
3- " " RECTUM
4- " " ROOM
MULVIHILL-HARVEY-DARROW

Fig. 6.

external iliac artery on one side, and the external iliac artery and vein on the opposite side the temperatures of both feet dropped gradually 22.°F. in a period of three hours to practically room temperature. Then after remaining at room temperature for about four hours it rose suddenly to 99°F., which was maintained thereafter. The greater part of this sudden rise in temperature took place in a period of twenty minutes, and seems to signify the establishment of collateral circulation by means of a vasomotor mechanism. However, it will be noted that there is practically no difference in the temperature curves of the two sides, and this was found to be true in all the other experiments. This curve also corresponds to the curve obtained by ligation of the external iliac artery as previously reported,[1] and shown in Figure 5. In no case did gangrene develop in either extremity.

SUMMARY

Consideration of the problem of simultaneous ligation of the companion vein when it is necessary to ligate a large artery has led to a review of the clinical and experimental literature and the presentation of our own experimental results. Review of the clinical literature leads us to believe that: (1) Most surgeons consider the incidence of gangrene of a limb following ligation of its main artery to be very high. Halsted did not concur in this view and made an elaborate analysis of all reported cases to prove his stand. Our own experience with dogs indicates that the incidence of gangrene in this animal following the uncomplicated ligation of the external iliac artery is rare. (2) Previous to 1916 every effort was made to preserve the accompanying vein in the belief that its occlusion increased the danger of gangrene. Since 1916 and the experience gained in the World War, this policy has completely changed, and many surgeons advocate the simultaneous occlusion of the accompanying vein when an artery is ligated to prevent gangrene and to aid in the establishment of collateral circulation. There are some discrepancies in the clinical statistics on which the advocacy of this

procedure is based. We have already considered the experimental data with which various authors attempt to establish the procedure on a sound physiological basis. In the light of our experiments here presented, and the previous experiments of Harvey and Ferris[33] in 1925, the earlier temperature experiments of Brooks and Martin[30] would seem to have been of too short duration to give an adequate idea of the effect of simultaneous vein ligation. Their experimental results on the incidence of gangrene in rabbits, however, are not disproved. On the other hand, Brooks[36] has questioned the conclusions of Holman and Edwards[34] based on the increased flow of blood from the distal end of the divided femoral artery, and we agree with him in this. Again, Holman and Edwards' comparison of their results on the incidence of gangrene in rabbits with those of Brooks and Martin is not conclusive because of differences in the methods of ligation. The contradictory results of Pearse[37] and Theis[38] in regard to roentgen findings after ligation and injection will need further rechecking. So it would seem that the experimental literature does not provide any sound physiological proof that the procedure of simultaneous ligation of the accompanying vein either decreases the incidence of gangrene or aids in the establishment of collateral circulation when a large artery is ligated.

Our previously reported experiments[1] on establishment of the collateral circulation in the dog, lead us to believe that the incidence of gangrene following the ligation of the external iliac artery, at least in this animal, is small. Consideration of the statistics from reported cases in the literature from 1900 to 1930 of ligations of the iliac and femoral arteries strengthens the opinion that the incidence of gangrene in the human following the uncomplicated ligation of these vessels either with or without ligation of the companion vein is smaller than generally supposed.

Finally the results of our experiments here reported indicate that in seven dogs, the temperature curve showing the return of collateral circulation was no different whether or not the accompanying vein was ligated with the artery. Furthermore, there was no gangrene in either leg of any of these dogs.

CONCLUSIONS

1. Review of the clinical literature indicates a belief in the high incidence of gangrene in humans following ligation of the large arteries. Since 1916 many surgeons have advocated the policy of simultaneous ligation of the accompanying vein when a large artery was ligated. This procedure was thought to aid in the establishment of collateral circulation, and to decrease the incidence of gangrene.

2. The experimental literature does not furnish any definitely proved sound physiological basis for the procedure of simultaneous vein ligation.

3. Our experiments on seven dogs indicate that simultaneous ligation of the vein has no demonstrable effect in aiding or retarding the development of collateral circulation as shown by the temperature curve at the periphery of an extremity of which the main artery has been ligated.

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[For Remainder of References see pp. 470 and 486.]

GAS BACILLUS INFECTIONS IN CIVIL SURGERY

A BRIEF DISCUSSION

WITH REPORT OF 7 CASES*

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GAS bacillus infection has been known since 1853 when Maisonneuve described it under the name of "gangrene Foudroyante." Pirogoff, a few years later, described the same condition under the name of "acute gangrenous edema." In 1891 Welch and Nuttall isolated from the human blood one of the causative organisms; this is known to us as Bacillus welchii or bacillus aerogenes capsulatus. From this time until the World War our knowledge of this infection was little enhanced. The frequency of this infection among the war wounded activated further investigation as a result of which much valuable information was brought to light.

Welch's bacillus (bacillus aerogenes capsulatus) was regarded as the responsible infecting agent and Bull and Pritchett in 1917, with the above as a basis for their work, developed an antitoxin for Bacillus welchii. In their experimental work at the Rockefeller Institute, they found that their antitoxin acted as a specific, therapeutically, on animals injected with cultures of this bacillus. Also they found that the antitoxin was quite as efficacious as a prophylactic. With the hope that the problem of treatment and prevention of gas bacillus infection would be solved by this antitoxin, it was taken to France where it proved to be a failure.

French bacteriologists studying the wounds of gangrene learned that bacillus aerogenes capsulatus (which Vincent found in 82 per cent of cases) was in association with other bacteria. The following organisms were then identified as coexisting etiologic factors of prime import in the causation of gas bacillus infection:

A. Pasteur's vibrion septique
B. Weinberg and Seguin's Bacillus oedematiens
C. Bacillus histolyticus and sporogenes
D. Bacillus fallax
E. Vincent's Bacillus fusiformis
F. Bienstock's Bacillus putrificus
G. Other anaerobes
H. Bacillus coli communis
I. Pyogenic cocci

Thus it appears that the combined efforts or symbiosis of several species of bacteria are required to produce gas gangrene. Tissier showed in his experiments that gas forming organisms in themselves had little power to cause gas gangrene but when affiliated with other organisms the typical disease was quickly produced. The aerobic associates, which are frequently pyogenic organisms, probably function by utilizing the available oxygen in the tissues and also by diminishing the patient's resistance. In further study of the associated activity of bacteria in the production of gas gangrene, Weinberg isolated two varieties of gas gangrene bacilli, the saccharolytic and proteolytic groups.

The saccharolytic group metabolize sugars and fats of the muscle resulting in the formation of butyric acid. The presence of this group of organisms in the wound is characterized by the sour odor and the brick-red color of the muscle. This partial destruction of the muscle tissue prepares the way for the proteolytic group to complete the destruction. Their presence is characterized by the odor of putrefaction which is typical for gas bacillus infection.

Gas bacillus infection has for a long time been recognized as a source of danger in

* The author wishes to thank Dr. Kirby Dwight for permission to use records of the cases on his service in Lincoln Hospital. Submitted for publication January 10, 1931.

war wounds but it is only in recent times that the same has been realized in civil practice. We feel that its incidence is frequent enough to merit consideration since at Lincoln Hospital we have had 7 cases in six years. Four of these cases terminated fatally, the three surviving ones had amputations done, two through the thighs and one at the shoulder. One of the fatal cases (B. O'M.) was treated with perfringens antitoxin. Peculiarly, the 4 fatal cases were admitted primarily for medical conditions. In 2 of these cases infection occurred about the site of hypodermic injection. Of the 3 that survived 2 were patients injured in street accidents and the third in a factory accident. It is of interest also to note that the surviving patients were all under twenty-five, whereas those who died were all over fifty.

CASE REPORTS

Case I. Bridget O'M., aged sixty-five years, a housewife, was admitted Jan. 17, 1927 for illuminating gas poisoning. She was unconscious on admission at which time a small abrasion of the lower right arm was seen. The next day an ecchymotic area surrounded the abrasion. The swelling increased and temperature rose to 102°F. Patient was promptly operated upon; multiple incisions were made; there was free escape of gas; cadaverous odor was present; brachial and antibrachial vessels were completely thrombosed. Following operation continuous wet dressings were applied. Temperature remained at 102°F. and pulse 120. Patient was given 2 doses of perfringens antitoxin intravenously (300 c.c. in all). Patient grew gradually worse and died about ten hours after operation. Vigorous stimulation and supportive treatment were without avail.

Case II. Oscar L., aged seventy-five years, a retired man, was admitted March 14, 1927, for chronic myocarditis with acute cardiac decompensation. On admission temperature was 96.8°F. and pulse 140. A few hours later temperature rose to 100°F. and pulse fell to 100. The following day the right arm was tense, markedly swollen, and crepitations were felt just above the elbow. (Patient had been given several hypodermic injections in this arm.) Temperature was 104°F. and pulse was 106; he appeared very toxic. He was taken to the operating room where long incisions to the bone were made anteriorly and posteriorly. The wound was irrigated with potassium permanganate; Dakin's tubes were placed in the wounds and permanganate irrigations q.2h. were given. Patient did not seem to rally following operation. Temperature was sustained at 104°F. for a time and then rapidly dropped to 98.8°F. Pulse dropped from 100 to 70. Patient died about thirty hours after operation.

Case III. Thomas M. aged ten years, while on street was struck by motor truck and injured about right knee. On admission to the hospital he was in shock, complaining of pain about right knee region. The upper end of the tibia and calf muscles were exposed through the lacerated wound. At this time his temperature was 99.6°F. and pulse 110. Fifteen hundred U. of T.A.T. were given. He was treated for shock. One and one-half hours after admission debridement was done and Dakin's tubes were placed in wound. The next morning temperature was 102°F. and pulse 122. The next day he was given a transfusion (340 c.c. of whole blood). Following this multiple incisions were made above and below the knee and Dakin's tubes inserted; wounds were irrigated with Dakin's at two hour intervals. On the third day, patient was toxic, temperature was 104°F., pulse 136, signs of gas bacillus infection were found and immediate amputation through lower third of thigh was performed. Wound was left wide open. Following operation temperature and pulse gradually came down, infection of wound gradually cleared up and patient was discharged in good general condition on April 15, 1927, forty-nine days after admission.

Case IV. Rebecca S., aged fifty years, was admitted Jan. 7, 1926 for chronic cardiovalvular disease with acute cardiac dilatation. The next day there was some ecchymosis about site of hypodermic injection; this region was quite tender; subcutaneous crepitations were present. Temperature was 100°F. and pulse 122. Arrangements for transfusion were made and on Jan. 9, 1926 patient was given 450 c.c. of whole blood. At this time the process extended from finger tips to left side of neck, left axilla and chest; the entire left upper extremity was markedly swollen, black, pulse-

less and crepitant. Affected region had very foul odor. Following transfusion extensive incisions were made over arm, forearm, chest and axilla. There was a free escape of gas. Muscles were black and there was marked foul odor. All groups of muscles were separated and opened as wide as possible. Excision of tissues was not done because of poor condition of patient. Evidence of an old hemorrhage was found in the axilla. The vessels of the region were thrombosed. Temperature dropped to normal; pulse rate was 100. The patient became gradually weaker and died the same day.

Case v. Harry W., aged twenty-three, a laborer, on June 15, 1923 fell from a ladder while at work, sustaining injuries to both his legs. On admission to the hospital it was found that he had a simple fracture of lower right leg and a 4 in. laceration over the medial side of left ankle through which the tibia protruded. Both left malleoli were also fractured. At operation that night laceration previously described was found to communicate with the ankle joint. Fractures were reduced and cast applied. The next day temperature and pulse rate were increased, temperature rising to 103°F. On June 19, 1923 some necrotic tissue was seen about the wound and there was a foul odor present. On June 20, 1923 a diagnosis of gas bacillus infection was made and disarticulation through knee joint was done. Temperature and pulse dropped. Temperature was irregular, rising to 101°F. and to 102°F. General condition gradually improved but wound was sluggish and healing very slow. Aug. 16, 1923 low thigh amputation was done, following this procedure patient rapidly improved and was discharged Sept. 19, 1923 after ninety-six days in the hospital. Anaerobic cultures from wound revealed presence of Bacillus communis coli.

Case vi. Nestor K., aged nineteen years, a machine operator, injured while at work, admitted to hospital Aug. 28, 1923 for compound fracture of left forearm. This patient's arm was caught in a machine and his body whirled in the air. Two days later temperature rose to 103°F., pulse to 124. There was ischemia of forearm, fingers were purple and cold. The limb as far as midarm was swollen and brownish in color. Crepitations could be felt as high as the axilla. Pulse at wrist was obliterated. There was a thin, yellowish, foul discharge. This same day the left arm was amputated. Anaerobic culture showed presence of gas bubbles. *X*-ray revealed rarified areas about fractures. These areas were interpreted as being due to the accumulation of gas. Following operation temperature and pulse dropped; toxemia subsided and patient improved rapidly. Subsequently the granulating stump was pinch grafted. Patient was discharged Oct. 13, 1923 after forty-six days in the hospital.

Case vii. Fannie U., aged fifty-five years, a housewife, admitted to the medical ward June 28, 1929 for diabetes mellitus and chronic purulent otitis media. After two days she was much improved. Temperature was about 101°F. and pulse 120. On July 2, 1929 temperature rose to 103°F. and pulse was 140. There was edema and tenderness about the ankle, also some swelling of left calf region and some tenderness along the tibia. It was thought at this time that patient was developing septic process about left ankle. White blood corpuscles 15,600 and P.M.N.'s 85 per cent. Blood cultures were taken. The following day the temperature and pulse dropped and patient felt better. On July 4, 1929 patient appeared extremely ill, temperature 98.6°F., pulse 100, blood pressure 70/45. Surgical consultation was requested. The left lower extremity was cold, had a sickening sweet odor, had a pale purple hue, was markedly swollen and there were crepitations present throughout the entire limb and even beyond Poupart's ligament. Patient was moribund at the time of this examination. She died the same day without operative intervention.

Of unusual interest were our 2 cases resulting from hypodermic injections. In a personal communication, Dr. Kenneth Taylor advised me that he had heard of several cases of gas gangrene following adrenalin. He believes that the cause of infection is probably due to local ischemia plus contamination. We believe that the usual precautions were observed and that the fluids were sterile. Both of these patients were brought in in severe cardiac decompensation. Since seeing I. M. Gage's article, we have felt that the source of these infections may have been the woolen blankets used.

These cases and the many others reported in the literature serve to confirm the opinion that gas gangrene is a virulent local and systemic infection which requires early diagnosis and prompt treatment if we are to reduce our morbidity and mortality rates. Extensive gangrenous areas requiring amputation may ensue in very few hours after infection takes place. Occasionally patients become extremely toxic and die in a short time.

For a clearer concept of this condition one should be familiar with the mechanism by which the disease is produced and also with the pathology that results. Previously the bacteriology was briefly considered. Gas gangrene is caused primarily by a group of anaerobic organisms. These bacteria grow best in muscle tissue. We would therefore expect this disease to develop in such wounds as have a diminished oxygen supply and injury or exposure of muscle. Gas bacillus infection most frequently takes place in deep wounds where the depth excludes oxygen. Lacerated and crushing wounds, hematomata and compound fractures, offer particularly favorable sites for the development of gas gangrene. Diminished blood supply to a part favors the growth of the anaerobes and the development of this gangrene. Bowlby points out that he had not seen gas gangrene in wounds about the face, head or neck and he attributes this to the copious blood supply of these parts. Gas bacillus infection is seen most frequently in wounds about the extremities. This has been explained on the basis of the more frequent contamination with dirt of these parts and also by the poorer collateral circulation in the limbs. We feel that the circumferential swelling acts as a tourniquet to produce a further ischemia which aids the process.

Once the organisms have been implanted the process extends longitudinally easily but extension across muscle from one to another is far more difficult. The bacteria grow rapidly at the site of infection. Gas and toxins are elaborated; autolysis of muscle takes place. The organisms spread between the muscle fiber and its sheath. A clear fluid is produced which separates fiber from sheath. Necrosis of the muscle follows and then the organisms invade the fibers themselves. The edema, gas and toxin act on the vessels and in turn cause a further ischemia of the part. The tissues are devitalized and soon there are extensive gangrenous areas undergoing putrefaction. The affected muscle appears dull, opaque and of brick-red color, resembling cooked meet. Even at this stage it is dead for it does not contract on stimulation nor does it bleed when incised. Later it becomes softer and gelatinous; its color changes to green, brown or black. With the local process under way, gas gangrene rapidly produces a severe systemic reaction. The pulse rate is quickened and the temperature rises. Acidosis is present. The patient appears gravely ill; the expression is anxious and signs of some degree of shock soon appear. Unless prompt treatment is instituted radical amputation becomes necessary to save life and in the more desperate cases death may soon follow.

The importance of early recognition cannot be emphasized too strongly. Ordinarily the patient is admitted with injury sufficient to cause tissue destruction. The usual routine treatment is begun and T.A.T. given. After a time, varying from six hours to several days and in some instances many days, the surgeon observes that his patient's progress is not satisfactory. There is increase of temperature and pulse rate. Severe pain, out of proportion to the trauma, is complained of in the wound area. Examination of the local condition will reveal swollen, tender, ecchymotic or brownish area around the wound. Usually there is thin, foul, pinkish discharge. Pressure about wound edges may effect escape of gas bubbles. Palpation may or may not disclose crepitations in region about the wound. In later cases the part is markedly swollen and discolored, red, purple, bronze or brownish; there is a characteristic decayed meat (sickening sweet) odor; the muscle tissue may appear brick-red or even black; and crepitations

can be felt unless the edema is so great as to hide them. Acidosis is present and so is shock, to some extent. Smears and cultures from the wounds frequently show the presence of the causative organisms. Cultures are really more useful to confirm rather than to make the diagnosis. *X*-ray reveals the gas bubbles scattered along the long axis of the extremity.

The early diagnosis of gas gangrene is usually not difficult provided its possibility of occurrence is constantly kept in mind. Dr. Armitage Whitman has pointed out to me that euphoria is frequently a symptom in gas gangrene. He has seen patients with temperatures of 104°F. or even higher who said that they never felt better in their lives. This feeling of euphoria persists almost up to death. It should be thought of and watched for in all cases of severe lacerated wounds, particularly of the extremities, crushing or gunshot wounds, compound fractures, etc. More than the usual pain in a wound, increased pulse rate and temperature, toxemia and shock should always make one suspicious. Smears, cultures and *x*-ray are helpful in those cases that develop slowly. The object is to diagnose the disease before the local signs are advanced. Marked swelling, discoloration, putrid odor, crepitations and escape of gas are late signs. Early diagnosis means early treatment and the results are always more satisfactory in those cases where the proper treatment has been instituted promptly.

Hendrig reports 4 cases of latent gas gangrene infection in wounded soldiers. These cases occurred about the sites of old injuries, some dating as far back as ten years, before the disease developed. These cases gave a long history of vague cramp-like pains without localization, periodic swellings, repeated breaking down of scars and prolonged ulceration without discharge. At no time did *x*-ray reveal air bubbles in the tissues.

Gas bacillus infection should always be considered as a serious illness; it is quite frequently fatal. The prognosis depends to some extent on the character of the infecting organisms. Prognosis is always poorer in those cases where streptococci are found in symbiosis with the anaerobes. The more superficial type offers a better prognosis than the deep type. The large, rapidly extending, fulminating type very frequently requires radical amputation; this variety naturally has the poorest prognosis.

TREATMENT

If we are to minimize the incidence of gas bacillus infection, we must always consider its development a possibility and do all in our power to prevent its occurrence. The causative organisms and the conditions most suitable for the development of gas bacillus infection are common knowledge and have been discussed previously. The condition may occur following slight wounds; in some cases only slight abrasions can be found; in some cases no break in the continuity of the skin can be demonstrated and in some cases it has followed hypodermic injections. One of us saw a case of gas bacillus infection in a case where the patient froze both feet. He refused amputation and gas gangrene developed. Thus we see that field or street contamination is not essential; nor must there be great soft part tissue destruction. Too great stress cannot be laid on prompt and thorough care of wounds. Skin cleansing and sterilization are very important, for Bacillus capsulatus aerogenes has been found on the skin, clothing and blankets of patients. In our series there were 2 cases resulting from hypodermic injections. Other writers have emphasized the fact that alcohol alone is not a safe skin sterilizing agent.

No set rules can be laid down for the treatment of wounds. The surgeon will plan his course according to the type of injury, the tissues involved, and the contamination. When the injury is of the crushing variety most writers agree that it is wise to excise the devitalized tissue in order to minimize the chance of infection especially by anaerobic bacteria. Daily inspection of the wound area is of the utmost importance.

As soon as suspicion of gas bacillus infection is aroused prompt incision (multiple long incision through skin, fascia and muscle sheaths to promote drainage and aeration and prevent ischemia) of the area should be performed. In the later cases when destruction of muscle is in evidence most writers advise excision of the devitalized muscle or even group of muscles. In the rapidly spreading, fulminating type, prompt amputation is indicated.

The reports on serum therapy appear contradictory and the efficacy of the sera (antitoxin perfringens and polyvalent anaerobic antitoxin) is still unsettled. Most writers believe that the sera are of some value in conjunction with surgical measures. All agree that serum, if used, should be given early in the disease and in sufficient dosage. Only 1 of our cases was given serum (antitoxin perfringens). This patient was a woman of sixty-five years (see case reports) with a severe infection which proved fatal.

Various chemical agents have been advocated for use in conjunction with surgery in the treatment of gas gangrene. The most important of these are hydrogen peroxide, potassium permanganate, Dakin's solution and Pilcher's mixture. Hydrogen peroxide and potassium permanganate were recommended in the belief that their power of oxidation would help check the infection. They have been used extensively without much beneficial effect. Dakin's is quite useful in ridding wounds of slough and aids materially in cleaning them up but it is not a specific formula for the anaerobes. Pilcher's mixture has been used because of the bactericidal action of quinine sulphate, which it contains. Pilcher and others report good results with this mixture. It is used like Dakin's solution. The mixture is not proteolytic and Pilcher has advised that after the anaerobic infection has been overcome, Dakin's solution be substituted for it.

No special mention is made here with regard to general supportive and systemic treatment as we feel that these and any other symptomatic therapy that may be indicated will be included in the management of the case.

In a recent article by Kling, normal horse serum is advocated for gas bacillus infection. While we have had no experience with this method and we do not wish to doubt its efficacy, we feel that the rationale of the method is not entirely clear. The advantages of adding normal horse serum to specific antitoxin appear problematical because the specific serum is, after all, horse serum and it seems more logical if larger doses are given that they be specific antitoxic serum.

In a disease of this sort so many factors enter into question of recovery that it becomes a matter for extremely critical judgment as to the value of serum therapy.

CONCLUSIONS

1. Gas bacillus infection should be constantly borne in mind as a possibility in all lacerated and crushing wounds.

2. We should be careful in our original care of these wounds, i.e., more careful with skin sterilization—excision of devitalized tissues—in order to reduce the incidence of gas bacillus infection.

3. Hypodermic injections should be given with greater care with respect to skin sterilization and the fluids should, wherever feasible, be introduced subcutaneously and not intramuscularly.

4. Gas bacillus infection should always be regarded as a serious condition.

5. Early diagnosis and prompt treatment insure better results.

6. In the diffuse, rapidly spreading, fulminating type affecting an extremity, early amputation becomes the treatment of choice.

7. Gas bacillus infection in those affected with myocarditis, diabetes mellitus and other debilitating conditions, is usually fatal.

8. The actual value of the available sera is still disputed. If given, it should be used early and in sufficient dosage.

[For References see p. 513.]

PERINEPHRITIC ABSCESS

A ROENTGENOLOGICAL AND CLINICAL STUDY*

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CLINICAL OBSERVATIONS

FROM a clinical point of view, the terms perinephritis and paranephritic abscess may be considered as identical. The simplest method of classification of perinephritic abscess is to divide the cases into two groups, those of renal and those of extra-renal origin. The preponderance of one type over the other is difficult of determination because the reports of cases in the literature are not entirely clear as to the source of the infection. A considerable difference of opinion exists as to whether or not a perinephritic infection, arising from a cortical abscess in the kidney, but hematogenously borne, shall be considered renal or extra-renal in origin. This may result in a considerable variation in the percentages of each type of case reported by various authors.

In 1909, Miller[1] found evidence of primary renal disease in 11 per cent of his cases while Braasch[2] in 1915 reported 56.4 per cent of his series as being renal in origin and Richardson[3] gives 30 per cent as the number in his report. Brunn and Rhodes[4] have recently written a clear and valuable essay on the mode of origin of the metastatic type of abscess which concurs well with our experience. It is these cases of extrarenal origin which are of chief interest from the diagnostic standpoint because of the difficulties which their recognition presents.

The mortality rate in perinephritic abscess is surprisingly high. The statistics, however, would probably be very different if the cases were properly classified as to the origin of the abscess. Hunt[5] in 1924 gave the mortality rate from various clinics as follows: Küster, 34 per cent; Miller, 14.3 per cent; Mayo Clinic, 6.6 per cent. These figures include both types of cases. Of the 106 cases reported by Hunt[5] from the Mayo Clinic no renal lesion could be demonstrated in 55.7 per cent. Where the distinction between cases of renal and extra-renal origin is made, a marked difference in mortality is noted. Scheele,[6] for example, reports no deaths in 20 cases of the metastatic variety while Miller[1] states that the mortality rate is about 40 per cent for abscesses of renal origin and 20 per cent in those of extra-renal origin. The latter figure is markedly higher than in our series and is well above the average.

The most obvious cause of a high mortality rate is late diagnosis. Mr. S. A. Lane[7] of Dublin puts the situation most cogently when he says, "Perinephritic suppuration in a previously healthy individual is not common enough for any one surgeon to have a preponderating experience in its diagnosis and it is doubtful whether any other abscess, or pus from any other situation in such phenomenal amounts, can elude detection for so long without seriously jeopardizing life." In 8 cases, which he reported, 7 were diagnosed so late that the lives of the patients were endangered. The mistaken diagnoses were variable including neurasthenia, rheumatism, sciatica, and hip joint disease, the last-named being the most favored. Two of his patients had their extremities put in traction and extension. Dunn,[8] Bransford Lewis,[9] and Braasch[2] have also commented upon the difficulty in diagnosis. The last one states, "I know of no condition in the field of urology which can be more difficult to diagnose."

The long duration between the onset of symptoms and hospitalization is well illustrated by the cases of Peacock[10] in

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which, so far as could be determined, it averaged 38.8 days. In 44 cases from the Mayo Clinic, reported by Habein,[11] practically the same time had elapsed before surgical treatment. Eisenstaedt[12] from Breslau found the interval between the etiologic insult and the correct diagnosis to average about twenty-five days. In our series, if 2 cases of doubtful origin are omitted, the average time from onset of symptoms to hospitalization was about 22.5 days.

Using ordinary clinical criteria the early diagnosis is not easy for there is no characteristic symptom-complex. According to Habein[11] the clinical course may be divided into two stages, that of symptoms only and that of symptoms with localizing physical signs. In order to decrease the long interval between onset and surgical treatment, the diagnosis must be made in the stage in which symptoms alone are present.

Chills, fever, malaise, loss of weight, and backache are constitutional symptoms present in the course of perinephritic abscess but also present in a score of other illnesses. A careful history inquiring especially into facts relating to cutaneous infection, acute respiratory infection, and trauma should be sought. No doubt, one of the most important items in early diagnosis is keeping the condition in mind.

Physical examination may be of little value. However, tenderness in the lumbar region, more frequently on the right side, spasm of the erector spinae group of muscles, and a fullness or bulging posteriorly between the twelfth rib and the crest of the ilium, when present, strengthen the impression. The bulging in the lumbar region may not be visible. Actual measurement of each side from the umbilicus to the spinous process of the vertebrae may demonstrate this fullness when it is not otherwise apparent. The leucocyte count is usually from 15,000 to 20,000.

We have collected 19 cases of proved perinephritic abscess, in 11 of which adequate roentgen examination was made. Table 1 summarizes the findings in these cases and needs little comment as to the clinical data. It is of interest to note the variety of diagnoses with which the patients were sent in to the hospital, emphasizing again the necessity of keeping this condition in mind. Only 2 cases were definitely diagnosed as perinephritic abscess and in only 7 cases was a renal or pararenal lesion being considered before admission.

Classification of the cases into renal or extra-renal types was determined largely upon a history or demonstration of active foci of infection, and a negative urinary history. The following cases may be cited as examples: boils (XIV), finger infection (XVI), marked oral sepsis (I), influenza and pleurisy (X), frequent tonsilitis and hypertrophied tonsils (XII and XIII). The history cannot be relied upon accurately for Case XVIII gave a history of frequent boils, "influenza" and pleurisy. That the perinephritic abscess was the result of a large cortical abscess was shown by operation. Thus the renal infection was probably hematogenous in origin giving rise to a secondary perinephritic abscess.

The average age in our group was thirty-two years; however, grouping the cases according to decades, we found the greatest number to occur in the twenty to thirty year period. All of the patients were operated upon, with one exception (Case VI), and there were no operative deaths.

In 2 cases nephrectomy was done. Case II had a functionless kidney as determined by cystoscopic examination; a perinephritic abscess was found at operation. Case XVIII was thought to have a renal tumor prior to operation, the diagnosis being based on a pyelographic defect which appeared quite characteristic of a neoplasm. This was seen to have been caused by a cortical abscess upon examination of the specimen.

The youngest patient (Case VIII) was two years of age. This case illustrates a common error in diagnosis and also the typical metastatic origin of many of the extra-renal type abscesses. The admitting

diagnosis was "hip disease, probably tuberculous." The first symptom noted was an apparent lameness followed shortly by inability to walk and a tendency to flexion of the right thigh. Prior to the onset of these symptoms the child had been ill with chicken pox. A definite diagnosis was established by needle aspiration followed by lumbar drainage.

Fig. 1. Right perinephritic abscess. Note shadows of psoas muscle and kidney on left and their absence on right. Cecum can be clearly visualized by its gaseous distention and it shows displacement toward spine.

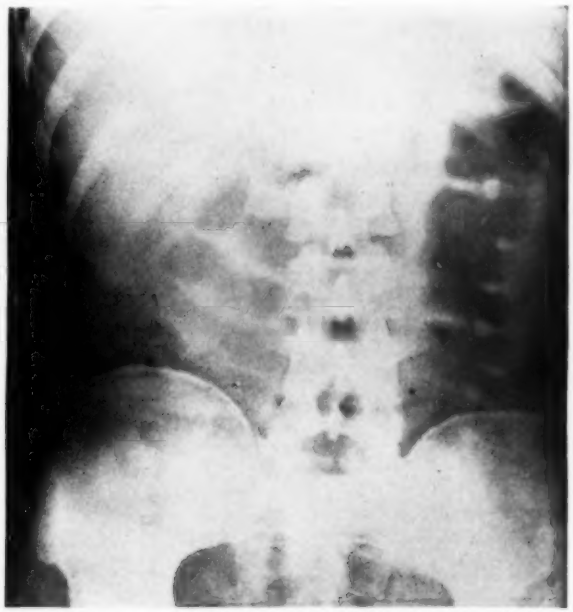

Fig. 2. Right perinephritic abscess. Note shadows of psoas muscle and kidney on left and their absence on right. There is a moderate scoliosis of lumbar spine with concavity toward affected side. Cecum can be clearly visualized by its gaseous distention and it shows displacement toward spine.

The only death in this series is that of the elderly man (Case VI) who died of uremia and sepsis resulting from prostatic hypertrophy. Upon admission he had 600 c.c. of residual urine, the blood urea nitrogen was 48 mg. rising to 112 mg. three days prior to his death. Post-mortem examination showed multiple abscesses in the left kidney apparently originating in the calyces and extending into the cortex. There was a large collection of pus about the capsule of the kidney.

ROENTGENOLOGIC OBSERVATIONS

To increase diagnostic accuracy at an earlier stage, roentgen examination may be of considerable value as has been recently pointed out in this country by Lipsett,[13] Beer,[14] Friedman,[15] and Brunn and Rhodes.[4] In roentgenograms of the urinary tract both direct and indirect signs of perinephritic abscess may be obtained. Both types of findings were first described by Alexander[16] in 1912, while a year later Koll[17] reported 4 cases illustrating the direct signs only. Since then Laurell[18] and Revesz[19] have described all the findings in considerable detail. Fritz[20] and Pancoast and Fussell[21] have especially called attention to upward displacement of the diaphragm on the affected side as an indirect roentgen sign.

The direct finding in the roentgenogram of an extra shadow, superimposed upon that of the kidney and representing a large, encapsulated abscess, is rare and of comparatively little importance. Calcification within the abscess has also been observed. We have had no experience with the direct signs so they will not be considered here.

The indirect signs are certainly more common and may be of crucial importance in the diagnosis of perinephritic abscess. The most important of these is an obscuration of the psoas muscle shadow accompanied by a loss of the kidney outline. Both of these are considered together as they almost invariably accompany each other. It is obvious also that this sign is of value only when these structures can be clearly made out on the normal side. These findings are illustrated in Figures 1 and 2. The psoas muscle on the normal side is seen as a fairly dense triangular shadow alongside the spine with the base of the triangle below. On the affected side this shadow cannot be distinguished from the surrounding tissues. Likewise the kidney shadow on the abnormal side cannot be seen although it is fairly well made out on the opposite side. The exact cause for the loss of distinction of these two structures is not entirely clear, but it is probably due to infiltration and edema of their fatty capsules. Normally, because of their low density, these serve to produce the contrast which makes the kidney and psoas muscle shadows visible. Infiltration with a more opaque substance destroys this contrast.

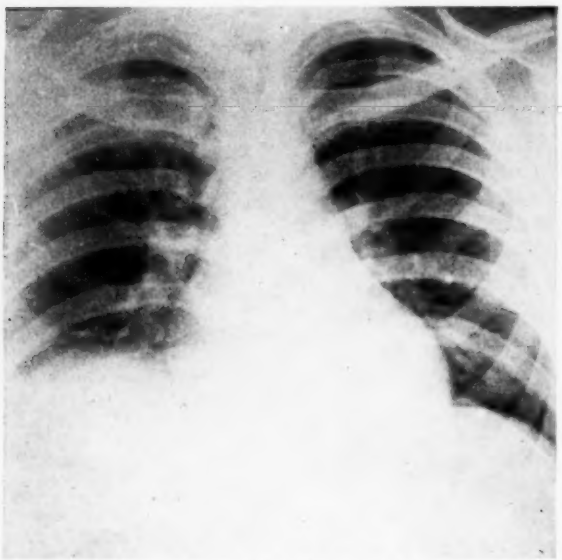

Fig. 3. Right perinephritic abscess with upward displacement of diaphragm. Note high position of right diaphragm and blurred irregular density above it. Appearance is typical of subphrenic abscess. Same displacement can be demonstrated in other cases on left side.

We have attempted, in human and dog cadavers, to determine how small an amount of fluid injected into the perinephritic tissues and into the capsule of the psoas muscle would cause obliteration of the psoas muscle and kidney shadows. These experiments were not entirely successful but tended to show that the loss of contrast in perinephritic abscess is not due to a simple collection of fluid but to the more complicated processes of edema and infiltration. This impression is borne out by the fact that comparatively small abscesses may produce an extensive obscuration of the shadows in the kidney region.

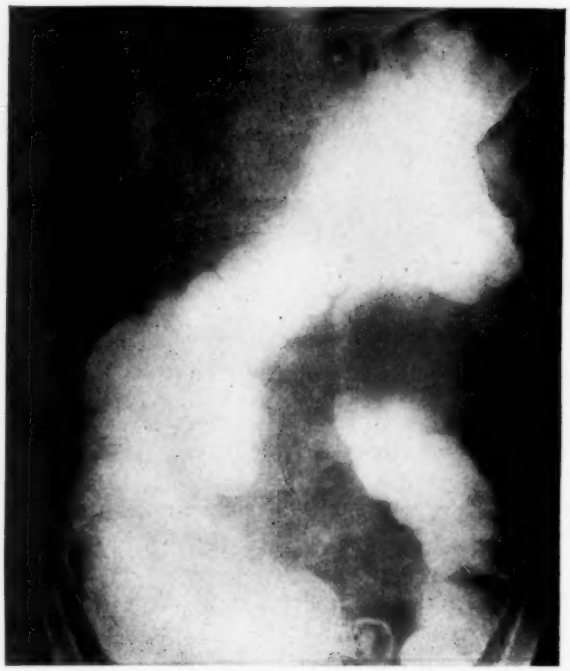

Fig. 4. Left perinephritic abscess. Barium enema reveals large pressure defect in descending colon which is also markedly displaced medially. (Courtesy of Dr. W. H. Ude.)

Scoliosis of the lumbar spine with the concavity toward the side of the lesion is another indirect sign which may be of some assistance. It may be very slight as shown in Figure 1 or more obvious as in Figure 2. Associated with this is an approximation of the costal margin and the crest of the ilium on the affected side.

The diaphragm on the affected side may be higher than normal and partially or completely immobilized. This is not at all

Fig. 5. Diagrammatic representation of most of roentgen findings in perinephritic abscess on right side. Note normal psoas muscle and kidney shadows on left and their absence on right. Right diaphragm is high and concavity of curved lumbar spine is to right. Right transverse processes of lumbar vertebrae are blurred. There is also an approximation of costal margin and crest of ilium on right.

a constant finding but when present is highly corroborative of the others. The appearance is much the same as that in subphrenic abscess as can be seen from Figure 3, a case of perinephritic abscess on the right side. The change in the diaphragm no doubt indicates that the infection has spread upward and produced a posterior subdiaphragmatic suppuration. In the case illustrated in Figure 3 the evidences of pleurisy above the affected diaphragm strengthen this impression.

The demonstration of displacement or deformity of the colon by the abscess, in our experience, is also corroborative evidence of considerable value. The colon may be visualized frequently by its gaseous distension as illustrated in Figures 1 and 2. Here the cecum is distinctly shown dis-

Fig. 6. Case xix. Perinephritic abscess with symptoms of only four days' duration and negative roentgen signs. Normal psoas muscle and kidney shadows on both sides are shown. Diaphragms and colon are normal in position. Slight scoliosis of spine had been observed before onset of this condition.

placed toward the spine. If the abscess is chronic a barium enema may be given and the displacement or compression observed. This is very well illustrated in Figure 4, a roentgenogram of a case of left sided perinephritic abscess (case of Dr. W. H. Ude, Minneapolis General Hospital). The marked compression of the descending colon by the abscess is well shown. Obviously any mass in this region may give this same finding.

Other signs such as obscuration of the shadows of the transverse processes of the vertebrae and erosion of the vertebral bodies are rare and of little importance.

A composite picture of all the possible findings, with the exception of colonic displacement and compression is illustrated in Figure 5. This is a diagrammatic repre-

sentation of the condition in a number of cases. The normal kidney and psoas muscle shadows are shown on the left. On the

Fig. 7. Polycystic kidneys. Left psoas muscle and kidney shadows are well shown but those on right are obliterated. There is marked scoliosis of spine with concavity toward right. (Courtesy of Dr. M. H. Nathanson.)

right they are quite invisible. The spine shows a concavity to the right while the transverse processes on this side are obscured. The right costal margin and crest of the ilium are approximated while the right diaphragm is much higher than normal.

In the group of cases of surgically proved perinephritic abscess shown in Table I, 11 patients underwent some form of roentgen examination. In addition we have collected 6 cases in which some of these roentgen findings were present but in which the disease was of a different nature. These two groups of cases lend themselves to a critical survey of the value of the various indirect roentgen signs both as to their negative and positive reliability. The findings in the latter group are tabulated in Table II.

Only 2 (Cases X and XIX) of the 11 cases of perinephritic abscess showed a complete absence of any of the indirect signs here described. The duration of the disease from the onset until drainage was instituted was shorter in these 2 cases than in any of the others reported, one being ten days and the other only four days. The normal appearance of the latter is illustrated in Figure 6. This appears to be the most reasonable explanation for the absence of signs and would seem to indicate that the diagnosis cannot be made in the very earliest stages by the roentgen method. This idea is further borne out by the findings in Case XIII and Case XVII. In the latter, ten days after the onset, there were no positive findings except for a high diaphragm but three days later almost all the characteristic findings appeared. In Case XIII the findings had begun to appear at fifteen days but were insufficient for definite diagnosis while at twenty-four days they were very characteristic. On the other hand in Case VII fairly definite roentgen findings were present eight days after the onset while in Case XVIII slight signs were present twelve days after, although the diagnosis was indefinite.

In all the remaining 9 cases in which a roentgen diagnosis could be made, obliteration, to a more or less degree, of the psoas muscle and kidney shadows was present. This was, therefore, the most constant and reliable sign. Scoliosis of the lumbar spine was present in only 4 of the cases and then to a very minimal degree. The diaphragms could not be properly observed in all of the cases examined because of improper technique. Of the 9 cases examined an upward displacement of the diaphragm could be seen in 5. In one of these (Case XVII) this sign was present before any of the others.

In all but 1 of the 11 cases, the colon on the side of the lesion could be clearly visualized, in the urinary tract films, by its gaseous content. Displacement to some degree, could be definitely made out in 6 of these 10 cases.

A small series of cases of different types, which might conceivably simulate perinephritic abscess clinically were selected for comparison. The findings in this group are shown in Table II. Thus a case of acute appendicitis, with perforation and general peritonitis (Case XX), gave the roentgen evidence of obliteration of the psoas and kidney shadows on the right together with scoliosis of the lumbar spine. Thes hort duration of the illness (one day) indicated the improbability of the diagnosis but from a pure roentgen diagnostic standpoint, the differentiation would have been impossible. Case XXI illustrates the effect of a large abdominal tumor which produced the appearance of all the signs. The massive shadow of the tumor itself was apparent so that no error in diagnosis resulted but this case illustrates the fact that a smaller tumor might simulate the roentgen signs of perinephritic abscess more closely. A case of pyonephrosis with marked destruction of the kidney (Case XXII) showed all the roentgen findings except the high diaphragm and was most difficult to differentiate both clinically and roentgenologically although the infection was confined within the kidney capsule.

Two cases of polycystic kidney (Cases (XXIII and XXIV) were also observed. In Case XXIV all the roentgen findings of perinephritic abscess (Fig. 7) except the high diaphragm were present. The clinical distinction was, however, quite obvious. The fact that polycystic kidneys may give a one-sided change in the roentgenogram simulating perinephritic abscess must be borne in mind.

The final case (Case XXV) illustrates a change in the psoas muscle shadow (Fig. 8) which must not be confused with that occurring in perinephritic abscess. This was a case of psoas abscess and shows a marked enlargement of the left psoas muscle shadow with lateral extension and some change in form. No obscuration of the shadow is present although scoliosis of the lumbar spine is also shown.

A critical summary of these cases would seem to indicate that the roentgen signs, while distinctly helpful, are neither pathognomonic nor highly reliable. In the very early stages, in our experience, the roentgen signs may be entirely absent or too slight for diagnosis. After the tenth day following the onset, *x*-ray findings may appear but may not be definite until a few days later. The absence of roentgen signs in the early stages, at least, does not rule out perinephritic abscess. After two weeks, however, the absence of roentgen signs may be considered of considerable significance. This close correlation with the value of roentgen diagnosis in acute osteomyelitis is notable.

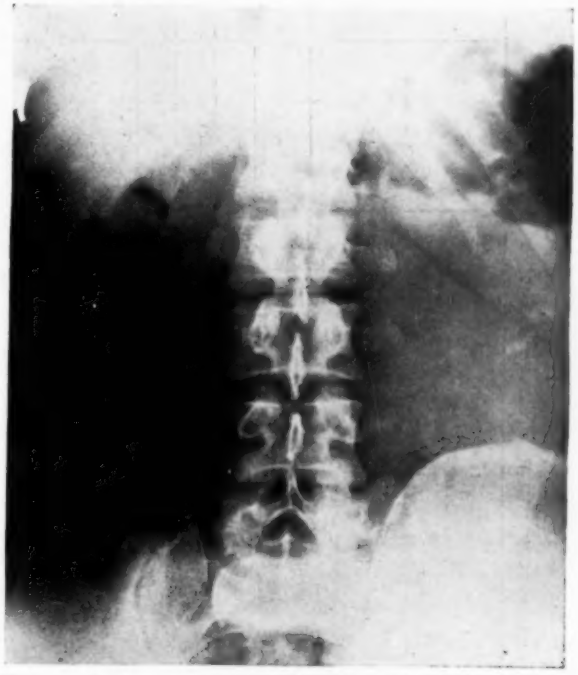

Fig. 8. Left psoas abscess. Left kidney shadow is obliterated but psoas muscle shadow can be seen greatly enlarged and bulging into flank. There is a slight scoliosis of spine with concavity toward affected side.

Of the abnormal changes in the roentgenograms which have been considered, the obliteration of the psoas muscle and kidney shadows on the side of the lesion is by far the most important. Nevertheless this finding may occur in a number of other conditions such as acute appendicitis with perforation, polycystic kidney, abdominal tumor, pyonephrosis of marked degree.

An upward displacement of the dia-

TABLE 1

OUTLINE OF CLINICAL AND ROENTGEN FINDINGS IN CASES OF PERINEPHRITIC ABSCESS

Case Number	Sex	Age	Type	Bacteria	Leucocytes PMNs	Urine	Pre-operative Temp.	Referred Diagnosis	Duration from Onset	Roentgen Findings				Treatment	Outcome
										Obliteration Psoas and Kidney Shadows	Upward Displacement Diaphragm	Displacement or Compression of Colon	Scoliosis of Spine		
1	M	38	Extra-renal	Staph.	24,000 84%	Neg.	102°	None	35 days	.....	.....	.....	.....	Lumbar drainage	Prompt recovery
2	M	37	Doubtful	Doubtful	19,000 74%	Neg.	99°	Renal neoplasm or calculus	70 days	.....	.....	.....	.....	Nephrectomy	Recovery
3	M	52	Extra-renal	.....	12,000 84%	Albumin and pus	100.4°	None	15 days	.....	.....	.....	.....	Lumbar drainage	Recovery
4	M	24	Renal	.....	18,600 87%	Pus	102°	Perinephritic abscess	? mos.	.....	.....	.....	.....	Lumbar drainage	Had bladder and renal calculi also
5	M	27	Extra-renal	.....	15,000 82%	Neg.	100°	Retrocaecal appendicitis	14 days	.....	.....	.....	.....	Appendectomy 6-5-22 Lumbar drainage 6-15-22	Recovery
6	M	63	Renal	.....	13,200 79%	Pus	.....	Prostatic hypertrophy uremia	6 mos.	.....	.....	.....	.....	.....	Died of uremia abscess found post-mortem
7	F	39	Extra-renal	No culture	11,000 79%	Neg.	100°	"Pleurisy"	30 days	.....	.....	.....	.....	Lumbar drainage	Prompt recovery
8	F	2	Extra-renal	Strept.	18,700 56%	Few leucocytes	104°	"Hip disease"	21 days	.....	.....	.....	.....	Lumbar drainage	Prompt recovery
9	F	53	Extra-renal	B. coli	28,600 85%	Albumin	100°	"Infection of kidney"	8 days	Present	.....	Absent	Absent	Lumbar drainage	Prompt recovery
10	M	46	Extra-renal	No culture	13,500 80%	Pus	100.5°	None	10 days	Absent	Absent	Absent	Absent	Lumbar drainage	Prompt recovery
11	M	31	Extra-renal	Staph.	22,000 83%	Neg.	102°	Retro-peritoneal abscess	20 days	Present	Slight	Absent	Present	Lumbar drainage	Prompt recovery
12	M	16	Extra-renal	Staph.	12,500 75%	Neg.	102°	Diaphragmatic pleurisy	21 days	Present	Absent	Absent	.....	Lumbar drainage	Prompt recovery
13	M	23	Extra-renal	Staph.	20,000 87%	Neg.	104°	Appendicitis	15 days	Slight	Slight	Absent	Absent	Lumbar drainage	Prompt recovery
									24 days	Present	Present	Present	Absent		
14	M	24	Extra-renal	Staph.	17,700 82%	Few casts	100°	"Hip disease"	56 days	Present	Absent	Present	Absent	Lumbar drainage	Prompt recovery
15	M	21	Extra-renal	Staph.	23,300 86%	Neg.	102°	Dislocated kidney or subphrenic abscess	21 days	Present	Present	Present	Present	Lumbar drainage	Prompt recovery
16	M	22	Extra-renal	Staph.	16,800 78%	Albumin	103°	Appendicitis	21 days	Present	.....	Present	Present	Lumbar drainage	Prompt recovery
17	M	33	Extra-renal	Staph.	15,500 80%	Albumin	104°	Sprained back	10 days	Absent	Present	Absent	Absent	Lumbar drainage	Recovery
									13 days	Present	Present	Present	Absent		
18	F	37	Renal	Staph.	14,400 84%	Albumin	100.8°	Abdominal abscess	12 days	Slight	Absent	Absent	Present	Nephrectomy	Pyelonephritis Recovery
19	F	25	Extra-renal	Staph. and Strept.	14,300 79%	Casts pus	102°	Perinephritic abscess	4 days	Absent	Absent	Absent	Absent	Lumbar drainage	Prompt recovery

phragm is also of considerable importance as it occurs rather frequently with perinephritic abscess. It will, of course, also occur with subphrenic abscess of any type, in certain intra-abdominal tumors, and in a variety of other conditions. The first two may simulate perinephritic abscess clinically.

Table II

OUTLINE OF THE ROENTGEN FINDINGS IN CASES OF VARIOUS TYPES OTHER THAN PERINEPHRITIC ABSCESS INDICATING THAT THESE FINDINGS MAY OCCUR IN OTHER CONDITIONS

Case Number	Roentgen Findings				Diagnosis
	Obliteration of Psoas and Kidney Shadows	Upward Displacement of Diaphragm	Displacement and Compression of Colon	Scoliosis of Spine	
20	Present	.....	.....	Present	Appendiceal abscess General peritonitis
21	Present	Present	Present	Present	Adenocarcinoma of ovary
22	Present	.....	Present	Slight	Pyonephrosis
23	Present	Absent	Absent	Absent	Polycystic kidneys
24	Present	.....	Present	Present	Polycystic kidneys
25	Psoas enlarged	Absent	Present	Present	Psoas abscess

Displacement and compression of the colon is a valuable sign as it may be present if the abscess is fairly large. It may, however, be present with any enlargement in the kidney region.

Finally scoliosis of the spine is of little value as a roentgen sign. It was present in less than half of the cases even in the later stages. It is a common finding in normal individuals and may occur with any acute abdominal condition causing pain, with any marked enlargement of any of the abdominal organs, and with abdominal tumors.

SUMMARY AND CONCLUSIONS

Nineteen cases of perinephritic abscess proved by operation or post-mortem examination are reported. Of these 16 were extra-renal, and 2 renal in origin while 1 was doubtful. Eleven cases were examined with the roentgen ray.

These cases illustrate the common errors in diagnosis and the usual long delay in the treatment of this condition because of the failure to diagnose it correctly.

Roentgen examination may be helpful in arriving at an earlier diagnosis of perinephritic abscess.

The most important roentgen sign is a loss of the normal psoas muscle and kidney shadow. Upward displacement of the diaphragm and evidence of displacement of the colon are next in importance. Scoliosis of the spine is of least importance.

The *x*-ray signs are frequently absent or doubtful up to ten days after the onset of symptoms. They are almost always present within fourteen days.

Six cases are reported including appendiceal abscess, abdominal tumor, pyonephrosis, polycystic kidney, and psoas abscess, in which the roentgen signs of perinephritic abscess were closely simulated. The *x*-ray findings are therefore valuable only as suggestive or corroborative evidence of the condition. Absence of the roentgen findings after a period of fourteen days from the onset should throw grave doubt upon the diagnosis of perinephritic abscess.

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[For Remainder of References see p. 570.]

CONDYLOMATA ACUMINATA COMPLICATING PREGNANCY

IN A WOMAN HAVING HAD FOUR PREVIOUS CERVICAL CESAREAN SECTIONS*

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REPORT OF CASE

History: Mrs. C. C. aged twenty-nine, was admitted to the Gynecological and Obstetrical Service of the Carney Hospital on October 31, 1930. She stated that she was pregnant for the fifth time. Her last period had started on February 20, 1930, making her confinement expected for November 27, 1930. Seven months previous to her admission she had noticed several discrete small warts about her external genitals; soon they began to coalesce into large masses and were accompanied by a thick, yellowish, irritating and very fetid discharge from the vagina. The discharge had existed for several months but she had paid no attention to it until the warty growths became troublesome. She was examined at another clinic, smears were taken and a Wassermann test was done. She was told to report for treatment but failed to do so. Sometime later she went to still another clinic where a diagnosis of gonorrhea and secondary syphilis was made. She was instructed to report for treatment but again this advice was not heeded. When her pregnancy had reached the beginning of the ninth month she appeared at my office and was referred to the Carney Hospital. She had had measles and pertussis in childhood, she had had her tonsils and adenoids removed at eleven years of age; otherwise she had always been well. Her family history revealed nothing of importance. She began to menstruate at the age of sixteen, her periods were regular, of the thirty-day type, lasting five days, she used four or five napkins a day, passed no clots and never had any pain. There was no bleeding between periods. The last period had occured on February 20, 1930. She had been married ten years and had four children, all delivered by myself, by the cervical cesarean section as follows.

PREVIOUS CERVICAL CESAREAN SECTION

1. March 20, 1922. Left occipito-anterior presentation. Justo minor pelvis. Large male child, cephalopelvic disproportion, twenty-four hour labor, floating head, one vaginal examination outside before admission. Veit-Fromme-Hirst transperitoneal cesarean section. The mother made a good recovery but the baby died at the end of five days.

2. August 20, 1923. She was delivered of a female child by a cervical cesarean section of the Kroenig type. The previous cervical scar was found perfectly healed. Both mother and baby were discharged well. This baby died of convulsions at the age of two years.

3. February 5, 1925. She was delivered of a male child by a cervical cesarean section of the Kroenig type. The two previous cervical scars were found to be well healed. Both mother and baby were discharged well.

4. April 10, 1926. She was delivered of a large female child, weighing 9 lb. and 5 oz. (4246 gm.), and presenting by the breech by a cervical cesarean section of the Kroenig type. The lower segment was thin but firm and the three previous scars could not be identified. No pelvic adhesions whatsoever were found. Both mother and baby were discharged well.

Physical Examination: There was evidence of healing scabies on admission. The teeth were poor and there was evidence of pyorrhea alveolaris. The heart and lungs were normal as were the breasts. The abdomen showed a healed median pelvic incision, it was symmetrically enlarged, the fundus of the uterus was two fingers breadth below the ensiform cartilage, the fetus was presenting by the vertex in left position, the fetal heart was heard in the left lower quadrant and was of good quality. The blood pressure was systolic 105 and diastolic 70. The vulva revealed a conglomeration of papillary excrescenses; multiple, diffuse, over the labia and extending on to the perineum, into the vagina and upward toward and around the urethra (Fig. 1).

The blood Wassermann test was strongly positive, but the complement fixation test for gonorrhea was negative.

* Submitted for publication April 23, 1931.

Since it was thought that the sloughing condylomata and the offensive discharge might be responsible for sepsis following cesarean section, it was decided to remove the infected masses surgically.

Fig. 1. Condylomata acuminata, covering vulva in quinquipara having had 4 previous cervical cesarean sections.

Operation: On November 3, 1930, spinal anesthesia was induced using 120 mg. of novocaine crystals dissolved in 3 c.c. of spinal fluid and reinjected. The vulva was prepared. The condylomata were dissected from the posterior vaginal wall, both labia majora, the anus and the anterior vaginal wall below the urinary meatus. The raw areas were approximated by interrupted sutures of No. 2 chromic catgut. A few small discrete condylomata were fulgurated with the actual cautery. A self-retaining catheter was introduced in the bladder, a pressure dressing was applied and the patient was returned to bed in good condition.

The histological examination of the removed masses led to the diagnosis of "Condylomata Acuminata."

The vulva healed readily, without complications. The patient was given an ampoule of gray oil by injection on November 21, 1930. On November 22, 0.900 mg. of neoarsphenamine was administered intravenously. This last treatment was repeated on November 25. The blood taken on this day showed a positive Wassermann test.

Fifth Cervical Cesarean Section: On November 26, 1930, the patient, having reached term, was prepared for operation. Under ether anesthesia the previous median suprapubic scar was resected, the peritoneal cavity being entered between the bellies of the recti muscles. Although this was the fifth cervical cesarean section, no adhesions whatsoever were found in the pelvis. The bladder was easily separated from the lower uterine segment for the fifth time. The lower segment was incised transversely with bandage scissors and a female child, who cried spontaneously, was delivered by the vertex. The placenta and membranes were expressed through the incision. The cervix was dilated from above. One cubic centimeter of pitocin and 1 c.c. of gynergen were injected in the thigh muscles. The uterus contracted well. The transverse cervical incision was closed in two layers, the first with interrupted sutures, the second with a continuous suture, burying the first layer, using No. 2 chromic catgut. The bladder was sutured back on the uterus with a running stitch of No. 0 chromic catgut in such a way that it completely covered the cervical incision and made it retrovesical. The omentum was brought down, placed behind the uterus, and the abdominal incision closed in layers.

Fig. 2. Vulva before discharge of patient from hospital.

Convalescence: The convalescence was satisfactory and unusually simple. The highest temperature was 101°F. (38.4°C.), on the fifth day, the pulse rose to 120 on the ninth day and the respirations reached 25 on the day of operation. The sutures were removed on the ninth day; the incision had healed by first intention. The patient was given a head rest on the tenth day and allowed out of bed on the twelfth.

The baby weighed 7 lb., 7½ oz. (3366 gm.) at birth. She showed no gross syphilitic lesions. She was placed on a modified milk formula and did well. Both mother and baby were dis-

charged on December 10, 1930, fourteen days after delivery. Both patients were referred for anti-syphilitic treatment.

At the time of discharge the abdominal incision was well healed, there was no induration and no tenderness. The vulva was healed (Fig. 2), the cervix was closed, the uterus was involuted, in forward position, movable and the adnexa and parametria were normal.

COMMENT

This case presented two important points of interest. First this woman apparently contracted gonorrhea and syphilis after her fourth cervical cesarean section. The presence of large masses of sloughing condylomata acuminata resulting in a fetid and infectious discharge made us fear that puerperal sepsis might result after the fifth cervical cesarean section which had to be performed in a month. While some of these lesions are amenable to conservative or medical treatment, we felt that during the time at our disposal better results would be obtained by surgical excision of the sloughing masses. Subsequent events proved this contention to be right. Secondly, we had the opportunity to see the abdominal cavity and to examine the lower uterine segment after four cervical cesarean sections had been previously performed. It was gratifying to find no abdominal adhesions whatsoever and to find the segment well healed and solid. This result may serve again to emphasize the fact that a cervical scar is safer than a corporeal one in the performance of cesarean section.

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[For Remainder of References see p. 486.]

*Continued from p. 452.

TUMORS OF THE FUNDUS OF THE UTERUS*

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IN a discussion of tumors of the uterus one is constantly impressed with the antithesis exhibited in tumor growth which occurs at the opposite extremities of the uterus.

The fundus is the site of the great classical myomatous tumors which represent the most conspicuous family of benign uterine growth, whereas the cervix is seldom the site of like tumors.

We find the cervix the most prevalent site of malignant growth in contradistinction to the comparatively infrequent occurrence of fundal malignancy.

We are further educated as to the contrasts of fundal and cervical newgrowths. We find fundal type of malignancy quite amenable to surgery, whereas cervical malignancy is less so. Again, malignancy of the cervix yields more often to irradiation than that of the fundus.

We also have exemplified in uterine growth the contrast between the active period of ovarian function in its relation to benign tumors as opposed to the frequency of malignant growth in the declining period of ovarian function.

Although function and injury play a part in bringing about the contrasts between fundal and cervical newgrowth, there is however sufficient distinction between tumor growths of the upper and lower poles of the uterus to be of definite value from the standpoint of etiology, pathology, diagnosis and therapeutic advice.

We are more concerned in this discussion of fundal tumors of the uterus with clinical history, diagnosis and treatment than we are with the histopathology of the subject.

The great size of the myomatous tumor of the fundus of the uterus affords the most spectacular field in abdominal surgery, the greatest operative desire for the beginning surgeon and often his Waterloo. Further, these large benign fundal tumors afford the greatest surgical tragedies of any condition amenable to abdominal surgery.

GENESIS OF MYOMATOUS TUMOR

Although all myomas probably exist early in fetal life as seedlings, we are not made aware of the growth until the active function of the ovaries is made apparent. It is pleasing to have even this bit of information in regard to the genesis of newgrowth of any nature.

Ulesko-Stroganowa says he believes:

> . . . that the genesis of uterine myomas can now be considered definitely established. Genetically they develop from the same cells on which depend both the physiologic growth of the myometrium and its physiologic hyperplasis during menstruation and during pregnancy. These cells comprise muscle tissue already present and embryonal (mesenchymal) rests, principally, and adventitial cells in the walls of the blood vessels. One of the chief stimulating bodies concerned in the development of uterine myomas is the ovarian hormone. In the absence of ovarian function (before puberty or in the climacteric) uterine myomas do not develop. The varied histologic pictures in uterine myomas are caused by the various degrees of differentiation of the young muscle cells and of the myoblasts. Malignant myomas develop as the result of an extremely rapid and unsurpassed multiplication of the young muscle cells and of the myoblasts that have lost the power of differentiation.

DIAGNOSIS OF BENIGN FUNDAL TUMORS

Too little attention is given to the diagnosis of fundal tumors. If the tumor

* Presented at the meeting of the American Association of Obstetricians, Gynecologists and Abdominal Surgeons in Niagara, September, 1930.

is not of sufficient size to be easily recognized as an abdominal mass, the patient most often presents herself to the hospital on account of possible uterine hemorrhage.

In dealing with uterine tumors hemorrhage is supposed to be the most frequent, alarming and most important diagnostic symptom in gynecology.

Although hemorrhage may easily be considered the most conspicuous symptom in uterine growth, I question whether it is the most constant symptom of benign growths of the uterus. Pain or discomfort is more often the sign of benign growth and is more often experienced in myomatous and adenomyomatous growth than in malignancy of the uterine fundus.

We have been taught that uterine newgrowth is without pain, it is my opinion such cannot be said of benign tumors of the fundus.

Dr. J. E. Davis of Detroit gives an excellent review of 335 hysterectomies performed in a city of 1,500,000 population by 35 operators in 6 different hospitals. This paper represents a cross section of the work done in a large city; the mortality was 4.68 per cent. The author gives as his message an appeal for more careful history taking and teaches as the triumvirate of symptoms of uterine tumors, pain, tumor and bleeding. Pain, 65 per cent of the cases; tumor of the abdomen, 40.8 per cent; hemorrhage, 31.3 per cent; sarcoma, 0.6 per cent; multiple growths, 86 per cent.

The percentages of the symptoms given in Dr. Davis' review are more in accord with my experience than is often given in popular teaching in our textbooks.

The symptoms of the benign tumors of the uterus are not so much due to the size of the growth as they are to location. Hemorrhage is much influenced as to location of the tumor in the uterine wall; the nearer the endometrium the greater the hemorrhage, whereas, the lower in the pole of the uterus the more the symptom of distress or pain is conspicuous. So the student of the subject by careful investigation should be able to develop the cause or reason why certain tumors are painful and others hemorrhagic.

The tumors which are the most difficult to remove are, as a rule, the most painful which is due to their pelvic position, such as interligamentary or subvesical leading to pelvic congestion, whereas, the big fundal tumors which rise freely into the abdominal cavity are, as a rule, without pain and surgically easily managed.

There is a great deal of truth and value in the thought that any newgrowth is both more symptomatic and destructive if its location is crowded or confined by unyielding walls. We see this principle exemplified in malignancy of the fundus as compared with the upper two-thirds of the cervical canal, and although we are aware that metastasis is much more fertile in the cervical region than in the fundus of the uterus, I yet feel that the unyielding and narrow cervical canal has a good deal to do with the rapid penetrating growth seen in the cervix.

Myomatous growths of the uterus are very prevalent in women past thirty-five years. Dr. Ill, of Newark, reports from an excellent and reliable review that 27.9 per cent of the white women in America over thirty-five years of age have myomatous tumors. We can safely add 10 per cent to these figures for the colored women.

Joseph Price often made the statement in his clinic that the uterus was intended to be an industrious organ and if it did not bear children it would bring forth a fibroid. There may be a definite relation between sterility and the myomatous growth of the uterus, but whether or not the growth predisposes to sterility or sterility in itself is a factor in the growth, is a proposition which requires more definite study as to physiology, pathology and etiology in the particular case.

We have already referred to the fact that the most active era in ovarian function bears a close relation to myomatous tumor and yet the active age of the ovary is the fertile age of the patient, just an

example of another clash between physiology and pathology.

ASSOCIATION OF THE MYOMATOUS TUMOR WITH MALIGNANCY

In a large percentage of fundal malignancies we have found associated myomatous tumors. The two growths are not often intimately associated with each other as to point of location, each existing as a distinct growth, with the exception of sarcoma.

Myomatous tumors of the fundus which have undergone a metaplasia and are revealed as sarcomas are of course more intimately associated with the benign myomas.

This association of malignant and benign tumors of the uterine fundus should constantly be kept in mind as hemorrhage may be the only common symptom of the benign and malignant growth.

It is a grave mistake to assume that hemorrhage from the uterus which has been taking place for from five to ten years could not come from a malignant growth. I have seen this many times, the removal of the uterus not revealing any other cause for the hemorrhage other than malignancy.

The myomatous tumor in the uterus has nomadic habits. There seems to be a tendency for the intermural growth to become more subperitoneal, later pedunculated or entirely cast off into the abdominal cavity, becoming a parasitic growth and nourished by adhesions to the abdominal structures. This change of position of the myomatous tumor can be accounted for by the fact that its circulation comes from the inside of the uterus and therefore the stroma between the growth and the peritoneum is constantly being pressed upon and as its circulation is interfered with the growth becomes more subperitoneal. Also there is a tendency for the intermural fibroid to become submucous, then pedunculated or even entirely cast off into the uterine cavity. I have seen 6 submucous growths as large as a small walnut detached and lying loose in the uterine cavity. The condition is always accompanied by a very odorous discharge which is quite diagnostic.

One should constantly keep in mind the pedunculated submucous benign tumor in dealing with supposed malignancy of the cervix. The most pleasing experiences of my surgical work have come from a recognition of a pedunculated submucous growth of the fundus of the uterus which had been delivered through the cervical canal and was exhibited as a great bleeding mass quite obscuring the entire cervix and having been diagnosed as late malignancy with hope abandoned. These conditions when kept in mind can be easily recognized. The diagnosis is made by passing the finger around the bleeding mass and recognizing the pedicle passing into the uterine cavity.

Dr. Ewing feels we should be more apprehensive in the heterotopic or extrauterine positions of the myomatous growth on account of a greater liability of the tumor as a source of sarcoma. I have always felt that the myomatous growth located in the broad ligament was more prone to sarcoma and one should be mindful of rapid increase in size of a benign tumor in extrauterine location.

THE ADENOMYOMA, ENDOMETRIOMA OR ENDOMETRIOSIS

I have always looked upon this tumor as a hybrid as it seems to have as its progenitors both connective and epithelial tissue. Clinically we have not been in the habit of attempting to make a differential diagnosis between fibromyoma and the adenomyoma. A careful study of the benign growth removed from the fundus of the uterus with an idea of associating the particular growth with the clinical history of the case, will quite uniformly reveal symptoms which are typical of the adenomyoma.

The adenomyomatous uterus may not be much enlarged, seldom over twice that of the normal uterus, it is very often a symmetrical organ, the growth often

principally involves the anterior and posterior walls producing marked thickening, may encircle the entire organ or appear as a local and definite growth.

Hemorrhage as a rule is profuse and pain is so often constant with the period that it may be looked upon as diagnostic of the adenomyoma.

The excessive amount of mucous membrane which is incident to and typical of the adenomyoma is the probable cause of the painful menstruation. The numerous glandular structures throughout the growth participate in the congestion incident to the menstrual period and thus the pelvic pain characteristic of the growth.

The uterus is the probable source of the adenomyoma. There has been much discussion in the literature by F. von Recklinhausen, Cullen and Sampson as to the source of this growth. They cite as probable sources the embryonic elements of the wolffian and müllerian fetal structures, Sampson taking the ground that the adenomyoma has its source in the mucous membrane of the uterus and that many of the extrauterine locations of the tumor may be accounted for by implants which have passed from the endometrium by way of the tubes and ingrafted the growth upon the pelvic and surrounding structures.

It is difficult to account for the source of the adenomyoma from any one of the theories which have come forth as popular teaching on account of the vagaries of the growth and its various locations.

Lockyer very well describes the condition when he says:

> We must regard adenomyoma as a hemorrhagic and painful structure which is found in bad company, its intimate associates being adnexal tumors, pelvic peritonitis, parametritis and infiltrations into the bowel wall, whilst it can claim caseating tubercle, carcinoma and sarcoma as casual acquaintancies.

The thought has been advanced that adenomyomas may form as an intermediate stage in the transition from an inflammatory to a malignant process.

It is good teaching to advise that a painful benign tumor which is not accompanied by adnexal infection is probably an adenomyoma.

The myomatous tumor of the uterus is often accompanied by the big white ovary. This I believe is often the source of pain which accompanies the myomatous growth.

Virchow referred to this type of ovary as due to an interstitial öophoritis with cystic degeneration, "which very well described its pathology.

Both the myoma and the adenomyoma are prone to cystic degeneration which may undergo further destruction and lead to a great cavity containing pus. This condition should be kept in mind when big tumors are being operated on.

Students so often ask just what is the true significance of uterine hemorrhage. The symptom is indicative of so many conditions both uterine and constitutional, that it is difficult to give a line of thought from which the student may reason. It has been our teaching for years that uterine hemorrhage is either due to pregnancy or not. If pregnancy is to be considered, we can, as a rule, by ordinary examinations plus clinical history of the case, dismiss the probability of placenta previa and abortion with retained membrane.

Tubal pregnancy is to be considered in uterine hemorrhage but the acuteness of the condition, paroxysms of sharp pain, moderate black discharge and a tender cervix, quite rule out possible uterine tumor.

Pregnancy in one horn of the uterus is to be considered in uterine hemorrhage. This condition can nearly always be palpated with considerable ease.

Uterine hemorrhage from either hydatidiform mole or chorioepithelioma comes up for serious consideration in dealing with possible fundal growths when hemorrhage is the most prominent symptom.

Uterine hemorrhage not due to pregnancy brings forth the thought of all newgrowths of the mucous membrane

of the fundus of the uterus and cervix plus those newgrowths which involve the entire uterine stroma. Hyperplasia of the endometrium is certainly of a tumorous nature. Constitutional conditions which may cause uterine hemorrhage belong to medical therapeutics.

SIGNIFICANCE OF CERVICAL POLYPUS

From experience we have learned to look upon the cervical polypus as a sentinel of like growth of the uterine fundus. The polypus coming late in life and after menopause cannot be dealt with as a single innocent lesion.

We have found that over 60 per cent of the cases of cervical polypus have shown tumor growth of the fundus, so we do vaginal hysterectomy in nearly all cases of cervical polypus unless there is a marked contraindication to removal of uterus.

It is a common experience to have the patient who has had a cervical polypus removed, come to the hospital on account of continued uterine hemorrhage. Removal of such uterus nearly always reveals polypi of the fundus, a submucous myoma or the condition of polyposis of the fundus which may be a forerunner of malignancy.

MALIGNANT CONDITIONS OF THE UTERINE FUNDUS

Fundal malignancy although much less frequent than cervical carcinoma must constantly and uppermost be kept in mind in dealing with fundal newgrowth.

Dr. Welsh in reviewing 31,000 cases of malignancy reports the uterus was involved in one-third of the cases.

The frequency of fundal malignancy compared with that of the cervix is variously expressed by men of large experience and integrity and their reports vary from 5 per cent to 30 as compared with cervical malignancy.

American authors report a higher incidence of fundal malignancy than authorities on the continent.

From my experience I would say, 5 per cent was low and 30 high; however, our experiences differ in certain eras of our work, and are also modified by methods of examinations.

Whereas carcinoma of the cervix is much more frequent than like growth of the fundus, sarcoma of the fundus is more frequent than like tumor of the cervix.

In my experience sarcoma of the fundus has been ten times as often seen as sarcoma of the cervix.

Sarcoma of the fundus of the uterus is most often found in intimate relation to a myomatous tumor and most often described as a malignant degeneration of a fibroid or myomatous growth.

Probably the term metaplasia would be a better description of the cellular change. The term degeneration should be used to describe a less active process or at least one used to describe a less active process or one where cellular growth is not stimulated. Malignancy is a stimulated growth of new tissue, whereas degeneration is a destructive process.

If the sarcoma of the fundus involves the endometrium it may appear as a discrete growth or exist as a diffuse condition of entire uterine fundus. The sarcoma which appears as a grape-like growth more often involves the cervix and at times in the very young. This cervical condition should be kept in mind.

Sarcomas in their intimate relation to myomas are rarely recognized until after removal of the tumor, so evidently the percentage of sarcomas as malignant fundal tumors is greater than is apparent, as many sarcomas are overlooked on account of their intimate association with the benign growth. This would register in favor of hysterectomy in treatment of fundal newgrowth.

It is impossible for the pathologist to examine all parts of the great fibromyomatous growths which so often involve the uterine fundus.

Pregnancy does not bear the important and definite relation to the sarcoma of the uterus that is found in carcinoma, for reasons which are apparent in cervical

injury, etc. However, the frequency of the benign fundal tumor so often seen in the nullipara may be a predisposing cause to the sarcoma which is so often associated with the benign tumor.

CHORIOEPITHELIOMA AND HYDATIDIFORM MOLE

Chorioepithelioma and hydatidiform mole occupy a most important place in the discussion of uterine hemorrhage and fundal tumors and if one does not have these conditions in mind a fatal lesion may be overlooked.

It is well to be mindful of the classification of hemorrhage from uterus as to whether or not it is due to pregnancy or any relation to a previous pregnancy, as we know that both chorioepithelioma and hydatidiform mole have their genesis in chorionic epithelium as the syncytium is a fetal structure.

To make a differential diagnosis between chorioepithelioma and hydatidiform mole is most difficult in many particulars. The clinical history may be most helpful. If the patient has had a normal labor and there is no evidence of benign tumor in uterine body and the placenta has been properly removed, then early and profuse hemorrhage following labor should make one consider chorioepithelioma; whereas, the distended uterus which is supposed to be pregnant, hemorrhage taking place and the organ of a more advanced size than the supposed term of pregnancy would allow, should make one think of hydatidiform mole.

The patient with hydatidiform mole often complains of a distending sensation of the uterus due probably to the rapid growth of the mole. If a grape-like mass which is characteristic of hydatidiform mole is protruding from the cervix, one has quite definite evidence of mole.

Diagnostic conflict must often come from an attempt to define the chorionic growth as to malignancy or benign tumor.

It is to be remembered that the trophoblast is normally invasive tissue even to a marked extent in normal pregnancy and also that trophoblastic pulmonary emboli occur in a large percentage of normal pregnancy.

Normal placenta remnants left in a uterus after full term pregnancy or miscarriage have not infrequently been taken for chorioepithelioma. Some pathologists do not consider the hydatidiform mole as a definite tumor but as a degenerative lesion.

Novak classifies the choriomatous tumors as choriomabenignum corresponding to the hydatidiform mole and choriomalignum as chorioepithelioma.

We are all the more confused in the proper interpretation of these chorionic growths when we are taught that they appear in ectopic locations, such as tumors of the testis and in patients in whom there is no history of pregnancy, for instance, in the very young virgin.

Even our most experienced pathologists claim that it is almost impossible to diagnose the chorionic tumors from uterine scrapings unless a portion of uterine stroma is removed with the specimen.

There is a marked contrast between the very acute and rapidly fatal outcome of some of the chorioepitheliomas and the more chronic and mild mannered forms of the growth.

The chorioepithelioma has been known to appear many years after pregnancy of either uterus or tube, the chorionic element remaining quiescent for so long and then appearing in a malignant form.

Statistics show that about one-third of all cases of chorioepithelioma follow a previous mole. It does not follow that one-third of all cases of hydatidiform mole are followed by chorioepithelioma; if so our duty would be to remove the uterus in all cases of hydatidiform mole.

Inasmuch as I have seen a number of very acute deaths from chorioepithelioma, I am each year more inclined to remove the uterus in the mole cases.

I have always been apprehensive for the patient in whom the uterus had been

curetted for mole. To curet the chorioepithelioma is a fatal mistake.

The accompanying lutein cysts most often bilateral may aid in the diagnosis. The cysts are more frequent with mole than with chorioepithelioma and tend to disappear when the uterine growth is removed.

The metastatic growth from the more chronic forms of chorioepithelioma will often disappear after removal of the uterus.

This factor of influence which is shown by the disappearance of distal implants or metastatic growth when the parent growth is removed is seen in the removal of the great papillary cysts adenomas; it is also seen in the removal of the cysts of the ovary which may be companions of the adenomyoma of the uterus and of like pathologic growth again seen in the removal of the uterus for chorioepithelioma and often seen in the removal of an abdominal tuberculous mass, or removal of one tuberculous kidney followed by improvement of the other.

In all conditions of malignancy of the fundus of the uterus, the lungs should be *x*-rayed for metastasis.

ADENOCARCINOMA OF THE FUNDUS

Adenocarcinoma is a type of fundal malignancy and it is not within the scope of this discussion to enter further into the histopathology of carcinoma of the fundus.

This type of tumor has various degrees of malignancy; its physical character as to exfoliating into the fundal cavity or penetrating rapidly into the stroma of the uterus may determine the prognosis, difficulty of diagnosis and treatment.

The condition is found, as a rule, ten years later than cervical malignancy; metastasis takes place late.

The ratio of this condition is 1 to 20 as compared to cervical malignancy. Pregnancy seems to have little influence, whereas, the childbearing woman is prone to cervical malignancy. Myomas are very often associated with fundal malignancy, not so often cervical.

The growth remains restricted to the fundus for a great length of time, even many years in a great percentage of cases. The prognosis is very good as compared with cervical malignancy.

TREATMENT OF FUNDAL TUMORS

We feel that treatment of fundal tumors is largely surgical and do not advise irradiation in either benign or malignant growth of the fundus. Regarding the great benign fibromyomatous growths of the fundus the treatment is hysterectomy.

Greater pains must be taken in obtaining a more accurate clinical history; heritage should be looked into. Undoubtedly there are instances of family predisposition to the benign growths of the uterus.

Mertini calls attention to heritage in cases of diffuse fibromyomatosis of the uterus in the very young with a history of severe dysmenorrhea.

A careful clinical history will often reveal a cardiorenal condition in the large benign tumor of the fundus.

We have almost abandoned myomectomy, first on account of the multiple tumor growths and again in those cases where the uterus is preserved for childbearing purpose the uterus has remained sterile. Other operators report more favorable results.

A greater percentage of sudden and unexpected deaths occurs following surgery of the fibroid tumor of the uterus than in any other abdominal operation. We have contended that there is a cardiac muscular change incident to the myomatous growth of the uterus.

We are unable to say that the benign fundal tumor produces a toxemia due to the newgrowth or degeneration in the way of tissue change, but there is often present this cardiac failure. The abdominal wall seems to increase in thickness which is certainly not legitimate tissue growth.

Evidently a good number of sudden deaths following hysterectomy of the big benign growths are not due to embolus. The patient with a large myomatous growth should be kept in bed a week or ten days before operation.

A close observation will often show a mental aberration in the patient who has carried a good-sized myomatous tumor of the uterus for a number of years, such mental change coming on near the age of menopause. Dr. Price often called attention to this mental condition.

During the past years we have had some experience with the treatment of fibroid fundal tumors by irradiation which is very significant. A number of these cases had been advised hysterectomy for fibroid growth; operation being refused, irradiation was done, the patient returning for hospital attention with a general malignancy of the abdominal cavity.

Whether or not the uterine growths were adversely affected or possible coexisting ovarian cystic growths were stimulated to a rapid malignant change, is quite impossible to say as the malignancy was so general that it obscured the initial point of involvement.

Mornard has reported a number of cases of extremely rapid malignancy grafted upon fibroid of the uterus following treatment by irradiation.

Professor J. L. Faure, of Paris, calls attention to the aggravation of ovarian tumors by irradiation during the treatment of fibroid tumors of the uterus. He refers to the rapid increase of size and possible malignant change.

It would appear from a summation of the entire problem involved in the treatment of uterine newgrowth, that we have the following features to consider. What is the value of the uterus to the particular patient? What is the price of its removal (mortality, morbidity, etc.)? If less radical methods of treatment are endorsed and the uterus is to be saved, how accurate is the diagnosis as to the nature of the expected growth? What are the risks of the methods of investigation, such as uterine curettement?

First must be kept in mind the tragedy of overlooking malignancy when the uterus is to be saved.

All conservative methods of treating uterine tumors must take into consideration the entire organ and not one of its extremities. We have no right to treat the cervix and always take for granted the well-being of the uterus higher up.

The mortality of removing the uterus is constantly being reduced by better organization and more masterful technique.

In a report of a series of 148 hysterectomies by Billroth in 1892, there were 65 deaths, so by comparison it can be seen what rapid progress has been made.

The mortality for hysterectomy over our country will range from 2 to 10 per cent and would be higher if the hysterectomy from above always included the cervix. So this may be the price of the hysterectomy as an abdominal operation.

We do vaginal hysterectomy by the clamp method in all cases where the size of the uterus permits. The mortality has been kept below 0.5 per cent in our series of cases.

Professor Zweifel says, "no one can say that radiation therapy has or ever will replace surgery by virtue of its superior results, this ideal goal will never be reached." One must always take into consideration the resistance to radiation which some types of malignancy exhibit, especially the glandular variety.

In our experience, 95 per cent of the patients in whom a hysterectomy is indicated are at an age when the uterus is of minor service, so there is little morbidity.

If we pit vaginal hysterectomy against the radical operation from above, will the more radical procedures when done for malignancy compensate for the very much higher primary operative mortality?

We have chosen the clamp method of performing a vaginal hysterectomy because it is a very much more radical procedure than when performed by the

ligature method and has a greater range of operability.

Probably it is necessary for me to qualify this statement as to the clamp method of removing the uterus having a greater percentage of operability than the ligature method. Dr. Adler, of Vienna, is doing a very radical vaginal hysterectomy by ligature method followed by irradiation with excellent results. His primary mortality is much higher than ours by the clamp method which might he expected from the very radical operation he does.

We have always claimed the sloughing of the tissues which are within the bite of the clamp further removes malignant or potentially malignant tissue.

The curette is most often used as a method of diagnosing fundal growths.

I have not been able to endorse the teaching that curettement of the fundus of a malignant uterus is without harm.

The statement is quite constantly made that there is no evidence of malignancy being transplanted or metastasis being increased from removal of uterine scrapings for diagnostic purpose.

It has been my experience that the patient who has had the uterus curetted one or more times has not the life expectancy if malignancy existed that she would have had without such procedure.

That curettement of the uterine fundus is frequently an imperfect procedure, is often shown by a postoperative examination of the removed uterus.

Malignant tissue just beyond a benign tumor of the fundus is often missed.

Infiltrating or penetrating malignancy of the fundus can be very easily missed and the deeper portions of the malignant glands of both fundus and cervix may not be reached by curettage for diagnostic purpose.

In considering treatment of the malignant uterus the histology of the entire organ must be kept in mind. The mucous membrane of the fundus of the uterus and the greater portion of the cervix are deeply penetrated by glands. The portio-vaginalis is without glands and it is my opinion that this histological fact may have a good deal to do with the favorable reaction of malignancy of the portio vaginalis to irradiation, as the growth in the portio vaginalis will remain as a superficial condition longer than would probably occur if its mucous membrane were deeply penetrated by glands.

To say that the uterus is benign or malignant is a very great responsibility to place upon the shoulders of even the most expert pathologists; especially is this so when the incriminating evidence may not be in the tissue that has been given in the uterine scraping.

I feel that many operators can report a greater percentage of operative victories or absences of recurrences in fundal malignancy than can be exhibited as percentage of accuracies by even a skilled pathologist from uterine scraping and I am not holding the pathologist culpable; he must be given the tissue from which to express his opinion. I have seen this failure very often.

I would like it understood that I hold no brief against scientific methods of investigation.

Many observers have classified the benign fundal tumors in accord with their amenability to irradiation.

Vaginal hysterectomy, clamp method, is fully illustrated in a monograph entitled "Practical Surgery of the Joseph Price Hospital."

Here again the uncertainty of radiotherapy comes in conflict with hysterectomy with almost a nil mortality in those tumors which can be removed by the vaginal route.

If the malignancy is confined to fundus and has not involved the cervix, which it rarely does, the prognosis is excellent. Operators can show 95 per cent of patients or better, living after five years. If the peritoneum of the fundus is involved then of course the prognosis is not so good.

THE FORMATION OF AN ARTIFICIAL VAGINA

A CONTRIBUTION TO THE 25TH ANNIVERSARY OF THE BALDWIN OPERATION*

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IT is now a quarter of a century since Dr. J. F. Baldwin, of Columbus, Ohio, devised an operation for the formation of an artificial vagina. It is only since that time that relief has been extended to the unfortunate woman born without a vagina, or whose vagina has been destroyed by trauma. His method gives a vagina that is not liable to either contraction or permanent stricture. All previous attempts along this line had been failures. By his method he utilized a loop of the lower end of the ileum for the lining of the new vagina, or in rare cases, in which that portion of the bowel could not for any reason be utilized, the sigmoid flexure of the colon.

Later on Popoff, and then Schubert, suggested the formation of a vagina by utilizing a part of the rectum. The profession, therefore, has at its disposal the two methods; the one utilizing the small intestine as a rule, the other utilizing a portion of the rectum. The question is as to which of these operations should be considered the preferable one.

In 1924, I made an attempt to solve the problem and succeeded in collecting very complete records of patients who had been operated upon by one or the other of these methods, and I concluded that the Baldwin method bore the palm.

A careful study of all the available records which I have secured by further effort and persistence, has seemed to me to establish two facts: (1), that the Baldwin method is possessed of a whole series of advantages over that of the Popoff-Schubert, and (2), that it is impossible to consider the latter operation as having, as claimed by its proponents, only a merely nominal death rate.

Since 1924, my statistical data have become more complete, and I am now able to report 390 cases of formation of an artificial vagina. Of this number the vagina was formed from the rectum in 148 cases (31 according to the Popoff method, 117 according to the Schubert modification) with a fatal result in 12 cases. By the Baldwin method there were 242 cases with 28 fatalities. (Ten different surgeons reported by the method of Popoff; 56 by that of Schubert; and 127 by that of Baldwin.) My questionnaire enabled me to become acquainted with practically all the Russian cases, but with only a limited number of those in other countries.

The first thing to strike one in studying the material is that the Baldwin method had been utilized by nearly twice as many surgeons as the Schubert, and that while the formation of a vagina from the rectum has been employed in but a limited area (Popoff in the U.S.S.R. and Schubert in Germany), the Baldwin method has been used throughout the world.

The unprejudiced surgeon will clearly see that it is by far safer, from the viewpoint of asepsis, to work on the sound intestine enclosed in its peritoneum and freely movable than on the rectum devoid of any peritoneal coating and imbedded in connective tissue. The technique of Baldwin's operation is also exceedingly simple and elegant, while the Popoff-Schubert method embraces some details which present certain technical difficulties, particularly that of circular resection of the upper end of the rectum, as acknowledged by Schubert himself.

Schubert also acknowledges that the gynecologists will prefer the Baldwin operation as this belongs to the type of operations with which they are most familiar, and that it will be difficult to show the advantages of the rectal method to the surgeon who has successfully used the Baldwin technique. Thus Frank, Brossman, Wertzeim, Martens and a number of other gynecologists who have used the two

* Submitted for publication January 19, 1931.

methods have finally decided that the Baldwin method is to be preferred.

In order to secure the authoritative opinion of surgeons as to which of the two methods should be preferred, I laid the subject before the Russian Surgical Society of Pirogoff, November 9, 1927, at which meeting I demonstrated a patient upon whom I had operated by the Baldwin method. At this meeting not one of the surgeons spoke in favor of the Popoff-Schubert technique. Professor S. P. Fedoroff declared that he preferred the Baldwin method for two reasons: first, because of its easier technique; second, because it was followed by fewer complications. This view was concurred in by Prof. E. R. Hesse, Prof. J. J. Djanalidze and others.

Practically the only argument advanced against the Baldwin operation is its *alleged* high mortality. In previous articles I have attempted to show that this argument is by no means well-founded, and that the mortality of the Baldwin method does not differ materially from that of the method by utilization of the rectum. A thorough study and analysis of the fatal cases reported as following the Baldwin operation clearly show that the alleged mortality in most instances was not due to the operation itself but to clear failure in technique. So far as the causes of death can be ascertained from these reports, there were several deaths due to tension of the mesentery of the transferred loop of bowel with resulting loss of blood supply. In 3 cases operation was made upon tuberculous patients, even with tuberculous peritonitis. In at least 15 cases death was due to peritonitis, which of itself would indicate failure in technique, and in the autopsies following in most of these cases failure to make a proper anastomosis caused the fatality. In 1 of these cases the abdomen was reopened, and a twist of the mesentery was found where the anastomosis had been made, and the anastomosis itself had an acute angle. In another case autopsy showed that gangrene had resulted from the compression of the mesentery by closing too tightly the opening through which the mesentery had been brought down into the vagina. In another, extreme tension of its mesentery was found to have been made in bringing down the intestine. At autopsy in another case relaxation of the anastomosis sutures was found responsible for the peritonitis. In 1 case, where the mesentery was too tense, the operator had made transverse incisions thus necessarily cutting off the blood supply. In another case the patient had had two previous abdominal operations (for appendicitis and volvulus) with extensive postoperative adhesions, and fatal tension of the mesentery followed. Two deaths are reported from anesthesia but no statement is made as to the length of the operation which had perhaps really been responsible for the fatalities. In 1 case, after incising the mesentery transversely to relieve tension, the operator was obliged to ligate "numerous bleeding vessels." In 1 case the anastomosis had been made so imperfectly that at autopsy ascarides were found crawling out. In one of the tuberculous deaths, occurring a month after operation, autopsy showed the field of operation to be normal, death being purely due to the pulmonary involvement. One death is reported (apparently from peritonitis) three years after the original operation but following the eighth operation made necessary because of ileus due to adhesions. Another death is reported six years after the original operation, a third operation having been made because of a persistent fistula which had followed a previous operation performed for ileus. One case is reported of death on the third day from peritonitis due to the transferred bowel having been so incarcerated as to have become necrotic. Five deaths are reported as due to causes unknown, there having been no autopsies.

From this statement it is very evident that in the large majority of deaths the fatality was due purely to faults in operative technique, or to anesthesia. Tension of the mesentery of the isolated intestine is noted in a considerable number of these cases, and such tension would necessarily

result in interference with the blood supply or in separation of stitches. Careful examination of the bowel before detachment in these cases would have shown to the operator that dangerous tension would result and the sigmoid should have been selected instead, as distinctly specified by the originator of the operation; or if no loop could be found that could be utilized, and the mesocolon of the sigmoid was too short, the operation should have been abandoned.

The finding of tuberculous peritonitis, if the previous history had failed to establish that diagnosis, would in most cases absolutely preclude the operation unless the sigmoid were found free of involvement. One can only be surprised at the temerity of the surgeon who fails to consider the changes which he finds present but insists on completing the operation.

By excluding the deaths clearly due to errors in technique, the mortality of the Baldwin operation is reduced to 6.5 per cent or less, which closely approximates the 5 per cent mortality which Baldwin believes should be the limit, and is less than the 8.1 per cent of the Popoff-Schubert operation.

In Baldwin's original communication, emphasized in his subsequent publications, he refers to his operation as one of a plain, straightforward character, but one that should not be undertaken by surgical tyros or by anyone who is not thoroughly experienced in intestinal anastomosis. It would seem to be self-evident, also, that this is an operation in which repeated experiences would be of value in reducing the operation to its safest possibilities.

Six deaths have been reported following the Popoff operation: 1. On the third day there was a purulent discharge from the pararectal tissues, and on the fourteenth day a rectovaginal fistula with bilateral pneumonia. Post-mortem showed a purulent pararectal proctitis with pus extending to the left kidney and gangrene of the lung. 2. Death from sepsis ten days after operation. 3. Death on the second day; post-mortem showed acute pelvic peritonitis and the portion of the rectum sutured to the anus gangrenous. 4. Death from septic peritonitis four days after operation. 5. Death from peritonitis seven days after operation. 6. Death in twenty-eight hours with weakened heart activity.

Deaths from the Schubert modification were: 1. Death nine months later after an attempt at closing a fistula into the bladder involving the urethra and sacrum. 2. Death from peritonitis three days after operation. 3. Death from sepsis on the third day. 4. Death from pelvic abscess (sepsis). 5. Death on the fourth day from severe sepsis. 6. Death on the fourth day from peritonitis and septic degeneration of the spleen.

It seems entirely evident that the Baldwin and Popoff-Schubert operations have essentially an equal operative mortality, but the Popoff-Schubert operation is likely to produce a series of severe complications which markedly decrease its value. Thus Popoff reports suppuration of the pararectal tissue with fistula formation; feeble sphincter ani, so that there was incontinence of feces and gas; a purulent passage between rectum and vagina with extensive and final complete necrosis, so that the new vagina and rectum made a common cavity with final complete loss of the vagina; on the seventh day a fistula into the pararectal tissue and a second one on the thirteenth day, the fistulae finally closing; several other cases with similar fistula formation; several fistula cases between the rectum and vagina, one at least remaining after a second operation made fifteen months later; shortening of the vagina from suppuration so that it was only 2 in. in depth. Other surgeons report similar failures necessitating repeated subsequent operations. A number report incontinence of stools and gas; one, a vagino-intestinal fistula.

Nearly 25 per cent of cases subjected to the Popoff-Schubert operation suffer from one or more of these complications, par-

ticularly the inability to retain gas and thin feces. From the frequency with which these complications occur it would clearly seem that they are necessary accompaniments of the principle of the method, and that the greatest caution together with the most perfect technique cannot always avoid them. The excessively fine manipulation of the rectum required within the region of the rectal tissues under conditions by which the operative field is inevitably contaminated with infectious material, and with insufficiently aseptic hands even when the gloves are frequently changed, all contribute to the formation of postoperative fistulae and other complications.

The presence of the abdominal scar by the Baldwin operation has been mentioned as a disadvantage, but such contention is too absurd to merit consideration, and such a scar is certainly no worse than the one which follows the Popoff-Schubert procedure: a scar on the back, particularly if connected with a resection of the sacrum, is certainly more undesirable than one in the linea alba.

In the Popoff-Schubert operation it has been sometimes found necessary to open the abdomen in order to secure enough tissue to complete the rectal operation, in which case the danger is greatly increased because of the immediate connection with an infected operative field.

The alleged excessive leucorrheal discharge following the Baldwin operation is largely mythical and probably invariably due to the employment of a superfluous amount of intestine. Correspondence with the originator, however, shows he has never had any such trouble, but he has always been careful to utilize only enough of the intestine to make a vagina of normal length. He also informs me that he has known of no case in which there was any postoperative stricture in the new vagina, or any other impediment to coitus.

Among my own patients there has never been a complaint of any permanent leucorrheal discharge, even a dose of physic producing no effect upon the vaginal secretion. No patient has complained of any form of dyspareunia.

The cases in which congenital absence of the vagina is associated with the presence of a functionating uterus are exceedingly rare, and while, when the uterus exists, the operation as originally advised by Baldwin should be so made as to permit of impregnation, that possibility is of only secondary importance, and if pregnancy should occur delivery of the child by Cesarean section if necessary would be a very simple procedure. If, however, the uterus is present the possibility of a normal delivery would be perhaps increased by using the sigmoid instead of the doubled ileum.

Conclusion: Thus we see that the Baldwin method presents no disadvantages as compared with the Popoff-Schubert, but on the contrary possesses a series of advantages over the latter which leads us to assign to it the first place and to consider it the method of choice. The advantages consist (1) in its being very simple and elegant; (2) it can be accomplised in a shorter time; (3) it allows the surgeon to work on the sound intestine with a peritoneal coating; (4) the vagina obtained by the method is so nearly normal as to be differentiated with the utmost difficulty; (5) there is no risk of incontinence of stools or a fecal fistula, so often observed as the result of the Popoff-Schubert operation; (6) it is much easier to observe the rules of asepsis and thus avoid septic infections; and (7) there is no resulting anal or rectal deformity. Thus, through the Baldwin operation we have been able within the last twenty-five years to aid hundreds of women, and by removing their terrible deformity to restore their peace of mind when they were not infrequently on the verge of suicide. The credit of the method which enables the surgeon, to whom the suffering woman turns with hope for relief, to effectually and without undue danger restore her to a normal condition should clearly be given to Baldwin.

THE MANAGEMENT OF CHRONIC PELVIC INFLAMMATIONS*

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NOWHERE is accurate diagnosis more desirable, more essential, than in the management of chronic salpingitis and its associated pelvic lesions. Salpingitis is hardly a good term, for only rarely is the lesion just that. Tubo-ovarian disease is open to the same objection. Chronic pelvic inflammation is at least comprehensive; and, although it does not direct our attention to the essential salpingo-oophoritis, it is better, perhaps, that it does not.

Good treatment is based upon a thorough understanding of the possibilities of the invading organism, proper appreciation of the frequency of regression and arrest of the lesion, the selection of cases for prolonged conservative treatment, the futility of partial operations in some patients, and the necessity for radical operations in others. Conservatism may be carried too far, yet thoughtless removal of one or both tubes and ovaries carries with it some mortality, much unnecessary mutilation, and the most discouraging end-results.

Over 90 per cent of tubo-ovarian infections are caused by the gonococcus. Pyogenic organisms, the tubercle bacillus and the pneumococcus, play but a relatively small part. Salpingitis is a relatively infrequent form of puerperal infection, appearing usually after injudicious use of the curette in abortion, or following obstetrical operations in which the cavity of the uterus is invaded such as version or manual removal of the adherent placenta. These patients are apt to be the worst, getting well slowly or not at all; usually streptococcal in origin, the organism often remains alive in the tissues for years, giving rise to serious local sequelae and adhesions without clear lines of cleavage. Operation may be done in these cases more readily, but only where the patient is reasonably safeguarded from undue risk.

The gonococcus, on the other hand, behaves differently. Its growth requirements, certainty of its early death, and knowledge of its long but sickly existence in the glands of Skene and the cervix, all speak for natural limitation of the infection. Operation should be done only for surgical treatment of sequalae which have defied all other forms of treatment. The infection may be managed by simpler procedures. Clinical improvement means cessation of bacterial activity within the tube; and exacerbations or recurrent attacks are never due to their regeneration, but always follow a new ascending invasion from the foci of infection in the external genitalia.

Removal of the adnexa without stamping out infection in every outpost of the invader is futile. The conservative operation will often be followed by a more radical one, and even panhysterectomy will not guarantee freedom from recurrent pelvic pain. If gonorrhea is as common as we are told,—and we know it is, and if it is the commonest cause of sterility,—and we believe it is, then it follows that most infections in women must result in absorption of tubal exudates, and complete recovery. Pregnancy is far too common to warrant any other conclusion. There is much evidence in support of perfect recovery, even when enormously swollen tubes have been felt or seen at operation. Acute or subacute tubes found when the abdomen of a young woman is opened for acute appendicitis should not be removed. Even low mortality never justifies that operation. The importance of preservation of proper ovarian function cannot be

* Read before a meeting of the Queensboro Surgical Society, Jan. 19, 1931.

overestimated, and it should not be forgotten that salpingitis is usually bilateral.

In the common absence of pelvic masses or the fixed uterus, diagnosis is made upon the history, and the stigmata of the gonococcus in the external genitalia. The importance of careful inquiry for typical urinary frequency, urgency and burning or stinging is obvious. Pain, discharge, dyspareunia, menorrhagia or amenorrhea are fairly constant. Palpation of adnexal masses is not at all essential. Smears are helpful but more often negative than positive. Diagnosis must never hang upon them for support.

Treatment should be all that we would wish it to be, were we ourselves the patients. That is true of any condition, of course, but, removal of ovary or tube, the commonest of pelvic operations, is often done for indications which are absolutely insignificant. Easy of access, simple to remove, so often suspected of complicity in all the ills to which poor female flesh is heir, they tempt the surgeon too boldly and so are summarily removed. Mortality is low. They are diseased. Convalescence is good. Why not remove them? Very little attention is paid to function, the most important consideration of all. Expediency, the real reason for most surgical intervention is by all odds the poorest argument. Women should be told that the slow arrest of the infection will be brought about by time and the natural development of immunity, that even two or three years is far preferable to ablation of organs which may be sorely missed, that operation can always be done if regression fails to occur, and that nothing is lost by delay, whether accompanied by proper treatment or not.

Operations should not be done in the acute or subacute stage, or even shortly after reinfection has subsided. Most gynecologists agree upon that. Although a few operators have achieved brilliant results this way, their case is not proved, nor can the average surgeon look for their low mortality, or expect anything but high morbidity.

Conservative treatment includes eradication of foci in Skene's glands and the cervix, abstinence from coitus, rest in bed for the first day or two of the menstrual period, anodynes for pain, occasional use of ice or heat.

The use of non-specific protein therapy is always worth while; although often disappointing it must be pushed to get results. Drastic cathartics are harmful, while glycerin enemas or gentle laxatives seem to act well. Pressure douches are distinctly harmful, while low douches, although their heat seems welcome, are not without danger too. I rarely use them.

Recurrent attacks of pelvic peritonitis are managed by Fowler position, fluids in every way possible, opiates freely, ice, and a small enema every other day. Peritonitis rarely spreads beyond the pelvis, and the pus-tube still more rarely ruptures. No vaginal or vulvar treatment should be carried on at this time. Occasionally abdominal or vaginal drainage of cellular tissue pus will be helpful.

Complete blood counts with occasional comparison of white and red cell counts and hemoglobin content help materially in estimating the severity of the infection and in measuring resistance. I have not found repeated transfusion of any considerable value in combating secondary anemia, but think much more of fresh air and sunshine, although use of the ultra-violet-ray for general surface radiation has been disappointing. Deliberate vaginal manipulation with careful observation of febrile reaction is a valuable criterion by which we may draw fairly accurate conclusions as to the coolness of the lesion, a simple test which involves no laboratory work.

The sedimentation time, however, is almost a specific test in determining the virulence of the infection and the best time for surgical intervention. More easily done than a blood count it is absolutely reliable, and can be depended upon as not misleading. It is probable that even slight reduction in the number of erythrocytes

will accelerate sedimentation time. So the test may show some error where anemia is a factor. It is not infallible when considered without the blood count, but is almost so, and for practical purposes is by all means the best test we have.

Endometriosis and chocolate cyst should be remembered as the commonest lesion in the pelvis in women about thirty-five, often associated with fibromyoma. Dysmenorrhea, rectal involvement and nodular infiltration of the posterior vaginal fornix are significant. Densely organized adhesions are the rule.

Tuberculosis is usually encountered in those who have apical involvement with symptoms of pain, menstrual anomaly, and an adnexal mass. Intact hymen at least suggests the diagnosis.

It is not easy, I admit, to select cases of chronic pelvic inflammation for operation: much depends upon judgment and that, of course, is not infallible. I operate upon those patients only, who have a steadily increasing drain of menorrhagia, or persistent dyspareunia in spite of treatment, or more closely recurring ascending infections, or those who have easily palpable masses giving symptoms after two years, and occasionally others who are so disabled that they are unable to earn their living and carry out the details of prolonged treatment at the same time.

In general conservative operations are not advisable, another argument for deferring intervention if partial operation is contemplated. Ruthless removal, the clean sweep, is only too often found necessary. My experience with the Bell Buettner operation has not been good, except as a temporary expedient. If both tubes and ovaries are sacrificed, the uterus should be removed as well. If but one tube and ovary are taken, the uterus should remain in spite of its size, unless its peritoneal surface is so denuded as to invite future trouble. Omental grafts may be considered in this type of case. Ovarian transplants are almost without value, the ovary faring best when left where it is found. Yet it is my experience that surgical separation of the ovary from the tube, accomplishes much for function but little for the relief of symptoms.

In my own work, with a large amount of clinical material in the wards of two large hospitals, I have not thought or acted except conservatively for the last fifteen years. Many operations have been done, not always wisely, sometimes unnecessarily, never for expediency, and always after careful consideration of all the factors in the problem. End-results are difficult to appraise, but repeated review convinces me of the soundness of conservative treatment.

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*Continued from p. 470.

THE TECHNIQUE AND ADVANTAGES OF WORKING WITH THE OPEN DUODENUM IN STOMACH RESECTION FOR PEPTIC ULCER*

R. Russell Best, M.D.

OMAHA, NEB.

ALTHOUGH repeated attempts have been made to solve a technique whereby the modern surgeon could perform gastrointestinal operations without the opening of the lumen, the results have not been satisfactory. After having served as an assistant in the von Haberer clinic, I am convinced that in stomach resections it is an advantage to work with a free wide open duodenum. As compared with the usual clamp method, I feel quite certain the incidence of peritonitis is not higher.

It is a matter of controversy as to indications and advisability of gastric resection in peptic ulcer, particularly duodenal ulcer and it is not the purpose of this paper to discuss this general question. Gastric resection has not only been criticized because of its higher mortality, which occurs because of the magnitude of the operation, but also it has frequently been stated that the percentage of permanent cures is no higher as compared with gastroenterostomy. From the number of patients with gastroenterostomies reoperated upon in the von Haberer clinic, I feel that the last statement is not correct. If in a reported series of cases the incidence of poor results is shown to be as high in resection as in gastroenterostomy, the faulty factor may not be in the principles of the operation but in the fact that the duodenal ulcers were not removed at the operation. As regards poor results, I particularly refer to so-called recurrent ulcers. The method of working with the open duodenum as used by Prof. von Haberer materially increases the possibilities of seeing and removing difficult duodenal ulcers.

The operation of choice in the clinic is the Billroth 1 and without using clamps one is able to perform this operation more frequently. By means of the end to end

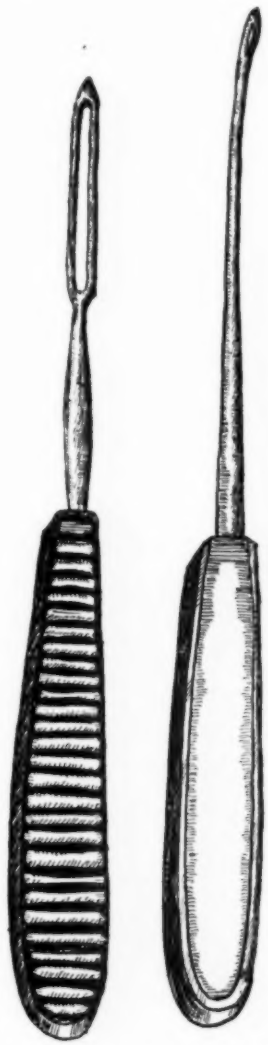

Fig. 1. Special fine perforated dissecting sound with aneurysm needle to match.

anastomosis the stomach empties directly into the duodenum whose mucous membrane and alkaline fluids are particularly adapted to the handling of the acid contents of the stomach. Naturally, marginal

* Department of Surgery, University of Nebraska, Omaha, Nebraska. From the Clinic of Prof. von Haberer, Dusseldorf, Germany. Submitted for publication February 24, 1931.

ulcers can less frequently complicate the operation. The direction of flow of intestinal contents is maintained and mechanical complications are less to be feared. Prof. von Haberer has never seen stricture of the duodenum following his technique of a Billroth 1. Further, only one segment of the gastrointestinal tube is disturbed, eliminating opening of the jejunum and secondary symptoms from surrounding adhesions and angulations. The danger of herniation into the transverse mesocolon is also eliminated.

Briefly, the technique in resection is carried out in the following manner. The right gastric and right gastroepiploic arteries are doubly ligated and cut. By means of very fine instruments (Fig. 1), repeated small bands of tissue are doubly ligated and the tissue cut between the ligatures. The tying off and freeing of repeated strands of tissues on all sides of the duodenum gradually mobilizes the duodenum. Adequate mobilization of the duodenum, exact hemostasis and minimum tissue damage are most important. A normal serosa on the posterior surface of the duodenum is an absolute prerequisite for a Billroth 1. The ligations of the gastrohepatic and the gastrocolic omenta are then completed. A Doyen clamp is placed just above the pylorus and the peritoneal cavity packed off with gauze. The pylorus

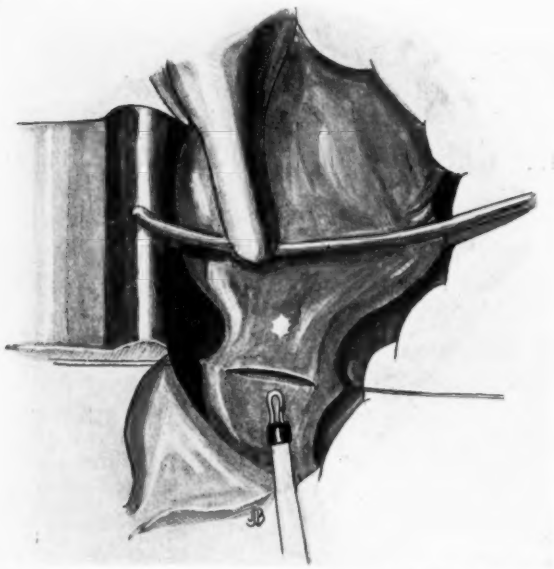

FIG. 2. Duodenum has been mobilized. Guide sutures are placed to control duodenum, avoiding use of clamps. Duodenal ulcer is present on anterior wall above line of cautery incision.

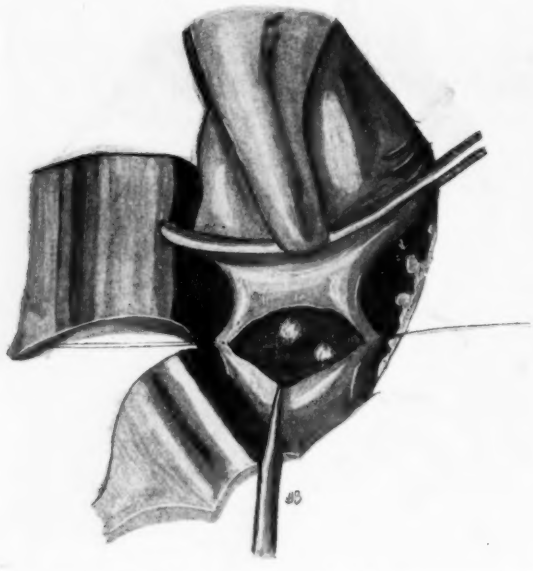

FIG. 3. Anterior wall of duodenum has been opened and posterior wall of duodenum is being examined. There are two ulcers present. It is probable lower ulcer would not have been seen or removed by clamp method.

FIG. 4. Free duodenum is further examined. Small piece of gauze attached to string has been inserted into duodenum to prevent regurgitation. Clamp has been placed on stomach and is being brought into approximation with duodenum.

is grasped between the thumb and two fingers of the left hand and slight tension made. Guide sutures are then placed on the upper and lower margins of the duodenum at about the planned level of severance (Fig. 2). These guide sutures are not tied but held slightly taut by an assistant. They serve to control the duodenal stump and thereby avoid the necessity of a clamp. A clamp on the duodenum not only traumatizes the tissue but also prevents the operator from seeing ulcers on the posterior wall which may be included in the clamp or are below the clamp. Without doubt, it is more frequently possible to do a Billroth 1, the most physiological-anatomical operation, when no clamp is used on the duodenum. By means of an electric cautery, the anterior wall is severed on a line below the level of the ulcers (Fig. 2). Usually a very small amount of duodenal contents escapes but this is quickly sponged away. The mucosa of the posterior wall of the duodenum is carefully inspected (Fig. 3). A small sponge on a string is then inserted into the duodenum to prevent any regurgitation of duodenal contents. The cautery then cuts through the posterior wall and by direct inspection the line of incision can in most instances be carried below the ulcers. With a clamp on the duodenum one does not only fail to see these posterior ulcers but also fails to remove them. If a duodenal ulcer cannot be removed, the Billroth 2 becomes the operation of choice.

Occasionally a posterior ulcer has penetrated into the pancreas and the tissue above and below the ulcer can be separated. The adherent perforation is burned off of the pancreas with a fine cautery, avoiding if possible opening of the ulcer. The area is further cauterized and covered with pancreatic capsule.

The stump of the duodenum is again closely inspected (Fig. 4). If a normal serosa is present on the posterior surface of the duodenum, a Billroth 1 is carried out. Occasionally the posterior wall of the duodenum is too short to make a safe anastomosis and rarely there occurs too much tension when the stomach and duodenum are approximated. An anterior Billroth 2 with an enteroenterostomy is then the operation of choice.

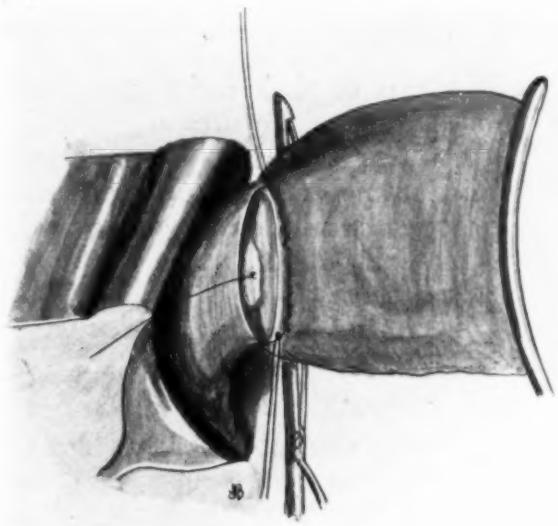

Fig. 5. Layer of interrupted Lembert sutures has been inserted securing stomach and duodenum. Anastomosis is then completed according to technique of Prof. von Haberer.

CONCLUSIONS

Provided that resection has been decided upon, working with the free open duodenum offers an excellent means to see and remove ulcers of the duodenum which many times are concealed in the closed clamp method. Another very important advantage is that the thin walled duodenum is not traumatized by a clamp. Further, the end to end anastomosis is the most physiological-anatomical operation and by working with the open duodenum, it can be performed more frequently and with less difficulty.

INTESTINAL OBSTRUCTION

DUE TO HERNIA IN DUODENOJEJUNAL FOSSA*

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NEW YORK

BECAUSE of their rarity, peculiarity of anatomical features and the difficulty of establishing a preoperative diagnosis, internal or retroperitoneal hernias are of especial significance to the surgeon. Up to the end of 1928, Garber reported, from a series of 134 cases, only 5 which were diagnosed prior to operation or autopsy

CASE REPORT

A. L.; female, aged seventy-eight years, was first seen May 18, 1930, complaining of generalized abdominal pain accompanied by vomiting and constipation of nine days' duration. There was no jaundice. Very little flatus was passed. Urinary symptoms were absent. There was no cough or loss of weight. Temperature was normal during this entire period.

The family history was negative as to malignancy and tuberculosis. The patient had had no miscarriages.

There was a definite history of attacks of indigestion, upper abdominal pain, vomiting, abdominal distention and constipation for the last twenty-five years. She had never noticed any evidence of tumefaction in the abdomen; nor had she ever had a serious illness or operation. The climacteric occurred at the age of forty-eight.

Physical examination showed a female, about seventy-eight years of age, who appeared toxic and dull. Breath was foul smelling and the tongue dry. Pulse rate was 120 per minute, temperature 104.2°F., and respirations 24. Superficial lymph nodes were not palpable. The heart and lungs were normal. Blood pressure was 80 systolic and 50 diastolic. The abdomen was distended and there were no tumor masses seen or palpated. Peristaltic or antiperistaltic waves could not be detected. There was definite rigidity of the abdomen and an indefinite resistance felt in the left hypochondrium. Vaginal and rectal examinations were essentially negative. The knee jerks were not elicited.

The patient's poor physical condition precluded the taking of a blood count and urine analysis. She was taken immediately, upon admission to the hospital, to the operating room, the diagnosis being intestinal obstruction.

The abdomen was opened by one of us (J. A. L.) through a 4½ in. right upper rectus muscle splitting incision. A quick search revealed the liver, stomach and gall bladder normal. With the exception of dilated loops of small intestine, nothing was seen or felt in the abdomen on general exploration. Since we knew that a lesion must be present, a rapid evisceration was performed upon hot towels and upon following the dilated loops of small intestine it was soon discovered that they led to a pocket in the fossa of Treitz. Ten feet of cyanotic gut were withdrawn from the pouch. This was wrapped in hot towels and after fifteen minutes the establishment of good circulation was accomplished. The mouth of the pocket was obliterated with 2 interrupted catgut sutures. Following the release of the incarcerated intestine the abdomen was closed in layers. The operation was performed under spinal anesthesia and during its entire course a small duodenal tube, introduced through the nose, was left in the stomach and considerable intestinal contents evacuated. The patient was sent back to the room with this tube in situ. Fluid was forced by skin, rectum and through the duodenal tube.

Several hours later the patient suddenly went into collapse, the temperature rising to 108°F. and died. Autopsy could not be obtained.

Certain recesses or peritoneal pockets are normally present within the abdominal cavity which merit interest because of their capability of causing internal hernias. The largest of these is the omental bursa; the others falling into 3 groups, namely: duodenal, cecal and intersigmoidal. The duodenal fossa is subdivided into (a) the inferior duodenal fossa (b) the superior duodenal fossa (c) the duo-

* Submitted for publication February 13, 1931.

denojejunal fossa or fossa of Treitz. The last-named is the one with which this paper is concerned.

This fossa can best be seen by pulling the transverse colon upward and pushing the jejunum downward and to the right. It is bounded on the right by the abdominal aorta, on the left by the left kidney, above by the pancreas and below by the left renal vein. It is normally 2 to 3 cm. deep and its orifice, directed downward and to the right, is nearly circular and will admit the tip of the little finger.

Studies of duodenojejunal hernias have all been based on the original investigations of Treitz who explained the occurrence of these peritoneal recesses or pockets on the basis of a failure of complete fusion of the peritoneal leaf during the process of rotation of the various parts of the alimentary tract from the straight vertical tube stage of early embryonic life to the definitive position assumed by the various components of the alimentary tube in later fetal life. The anatomico-embryological construction of the duodenojejunal fossa has further been studied by Journesko, Bender and Lukianow,[1] Moynihan,[2] Andrews,[3] Gruber,[4] Landzert,[5] Eppinger,[6] Waldeyer,[7] Broesike,[8] and Eisler and Fisher.[9] These observers have described various pockets in the fossa of Treitz which make the subject a bit confusing. There are 2 locations however which are significant as regards the formation of Treitz's hernia: that is the upper horn of the duodenojejunal fossa carrying the inferior mesenteric vein and the lower horn in which according to Broesike the so-called mesocolic recess occurs.

Andrews believes that Treitz's hernia is due to a congenital anomaly in the development of the peritoneum. Basically the anomaly results from a developmental and rotational restriction of the duodenum and intestinal loops, as a result of which there occurs a false position of the intestinal loops which prevents the formation of normal adhesions of the mesentery with the posterior parietal peritoneum resulting in the formation of large pockets or hernial sacs. The supposition of Treitz and Wolms that the duodenojejunal fossa may distend from the pull exerted by the intestine to such a degree as to form a true hernial sac has been doubted by Garber in the light of recent embryological knowledge.

Indisputable signs in the recognition of duodenojejunal hernia other than the position of the inferior mesenteric vein are the anatomical position of the hernia, the size of the sac and its content, usually a large portion of small intestine.

A correct preoperative diagnosis is exceedingly difficult to make as is borne out by the fact that only 5 cases were correctly diagnosed; (1) by Abraszow, (1) by Vautrin, (1) by Staudenmeyer, and (2) by Haberer. These have been established either by operation or necropsy.

Garber considers the following symptoms of a Treitz hernia as very suggestive:

1. Dyspeptic phenomena such as constipation, diarrhea, and a sense of heaviness in the abdomen.
2. Periodic distention of the abdomen.
3. Sensation of an elastic tumor in the left hypochondrium.
4. Tympanitic resonance over the abdomen.

In the acute stage the signs of ileus with the presence of a palpable tumor in the left hypochondrium help to establish the diagnosis. In any intra-abdominal crisis if one would always consider the possibility of internal hernia, incorrect diagnosis and subsequent improper treatment would be avoided.

In the treatment of these hernias the sac should be resected if the vessels permit, followed by obliteration of the hernial orifice with sutures. After removing the hernial contents, all that is necessary, at times, is to close the aperture with a few sutures. The prognosis depends upon the interval elapsing between the onset of symptoms and the institution of treatment. Operation, performed early, warrants a good prognosis.

[For References see p. 538.]

A CLINICAL DISCUSSION OF

NON-ROTATION OF THE LARGE GUT

WITH REPORT OF TWO CASES*

NELSON A. LUDINGTON, M.D.

NEW HAVEN, CONN.

CASE 1. Dr. Stetson attended W. B., a sixteen year old boy through three mild abdominal episodes within a period of three months. On each occasion there was a history of indiscretion in diet. There was no history of attacks prior to his first observation of the case. The cramp-like pain was on each occasion local from the start, and located about midway between the umbilicus and the symphysis pubis in the midline and about equally across the lower abdomen both to the left and to the right of the midline. No definite local point of maximum tenderness could be elicited. Each attack lasted about thirty-six hours. The first two were afebrile. In the third attack his temperature reached 99.4°F. by mouth. Pulse ranged in the eighties. He vomited once with each attack, about three hours after the onset of pain and temporary relief of abdominal pain followed. The doctor was finally able to persuade the parents to accept his diagnosis of appendicitis and the patient was admitted to the New Haven Hospital May 25, 1930.

FIG. 1. Complete non-rotation of colon. Barium enema.

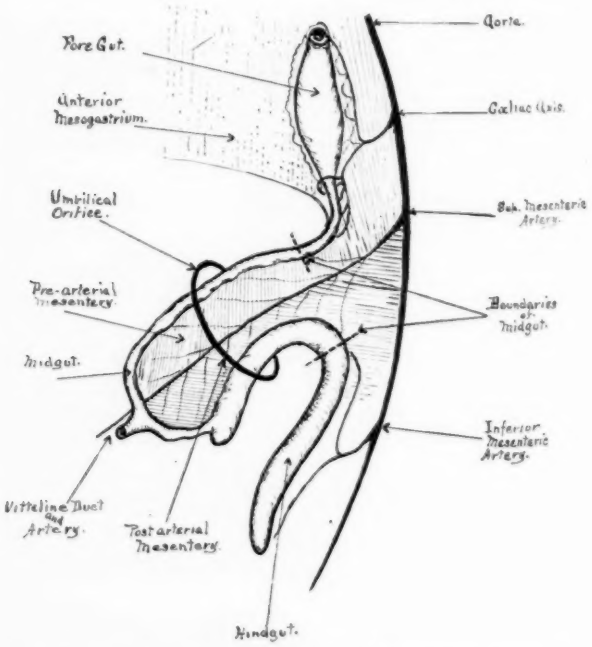

FIG. 2. Conditions of primitive alimentary tract at fifth week. The three main subdivisions are seen to constitute three loops—foregut, midgut and hindgut. Aorta is representative of axis of body. From it the three loops are suspended by their common mesentery, in sagittal plane. In mesentery special arterial blood supply for each loop is represented. Midgut loop is already large and has been extruded into umbilical cord. The cecal bud is appearing.

Pre-arterial mesentery is indicated by vertical shading. Postarterial mesentery is indicated by horizontal shading. (From Fig. 179, p. 253. Dott, N. M. Anomalies of intestinal rotation. *Brit. J. Surg.*, 11: 251, 1923–1924.)

On admission, temperature, 99°F., pulse 84, white blood corpuscle count, 14,600. Seventy-nine per cent polymorphonuclears. There was an area of tenderness just to the right of the midline 2 in. below the umbilicus. The right rectus was more resistant than the left in its

* I am indebted to Dr. Paul R. Stetson for the privilege of using the first case herein recorded and whose roentgenogram is Fig. 1. The other case occurred some years ago. Submitted for publication February 13, 1931.

lower segment. There were no bladder symptoms. The abdomen was uniformly tympanitic. An enema in the afternoon had yielded a good result (mother's statement). There was on reason to suspect that the appendix occupied any but the usual position in the abdomen.

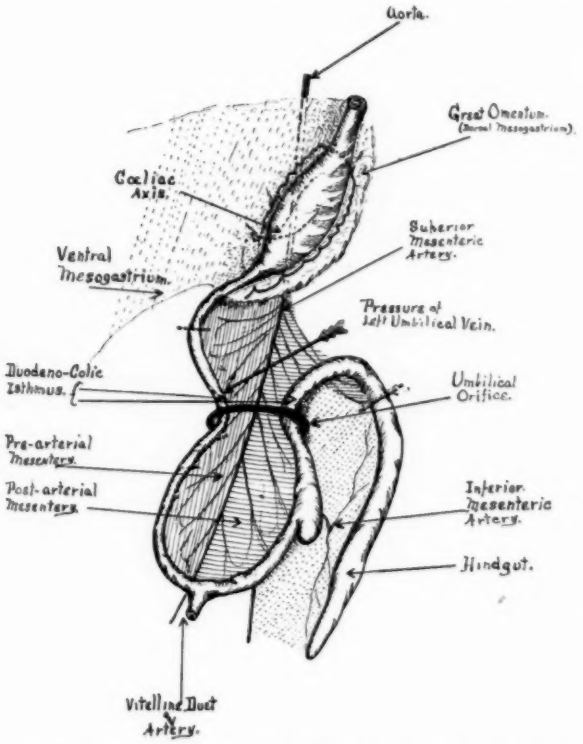

Fig. 3. Same stage as preceding figure, viewed from ventral aspect. Same points are brought out. Note especially right-sided position of small intestine and left-sided disposition of large at this early stage of rotation process. In condition referred to as "non-rotation" these relations are maintained. (From Fig. 172, p. 255, Dott, N. M. *Idem.*)

A McBurney incision disclosed only a mass of small intestines. Following the parietal peritoneum down from the wound across the psoas muscle failed to locate a mesocolon. We arrived at the spine. Search upward, through the extended original incision, exposed a normal gall bladder. The greater curvature of the stomach was brought into the wound and presented a curious appearance. It was entirely devoid of gastrocolic mesentery from the pylorus to a point well to the left of the midline of the greater curvature. The vessels of the greater curvature were small and the spaces between those visible on the anterior wall of the stomach were much wider than usual. Nothing abnormal was noted in the lesser curvature. The duodenum was picked up and followed down for about a foot. It was freely movable on a long mesentery. It did not cross the spine. It was not fast to the spine. I did not examine the foramen of Winslow.

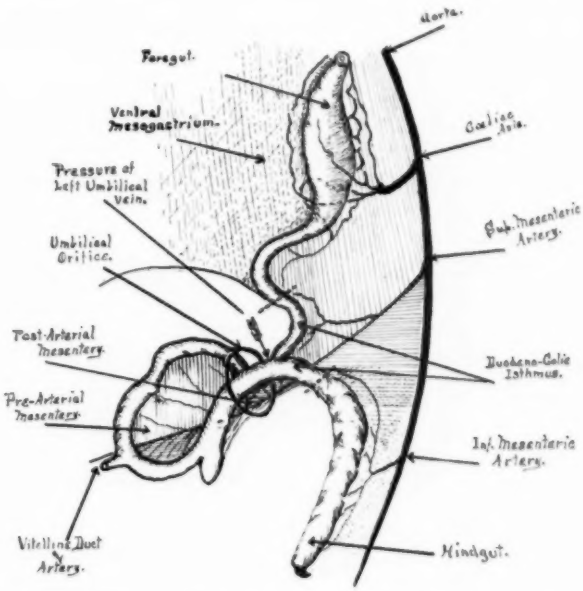

Fig. 4. Representing conditions of alimentary tract about eighth week. First stage of rotation is being accomplished. Arrow indicates pressure being exerted by left umbilical vein on pre-arterial loop, forcing it downwards and to right. Note narrow duodenocolic isthmus at base of loop, with superior mesenteric artery running through it. (Copied from Dott. *Idem.*)

Reaching across the abdomen I was unable to find any great omentum. I could feel something attached to the extreme left of the greater curvature of the stomach but could not bring it into view. I could not identify a transverse colon.

Shifting to the pelvis, the cecum was found deep in the hollow of the sacrum in about the midline. That is the ileocecal valve was about in the midline but the bulk of the cecum occupied the left pelvis. The ileum entered the cecum from the right side instead of entering from the left as is usual. The appendix was rather longer than usual but otherwise appeared quite normal on the outside. Its mesentery was free as was that of the cecum which delivered into the wound easily. The vessels appeared quite as usual.

Routine appendectomy and wound closure. Uneventful convalescence.

Pathological Note: Cross-section. The specimen consists of an appendix which measures

about 11 cm. in length by 7 mm. in greatest diameter. Throughout it is fairly uniform in size. The serosa presents a greyish appearance.

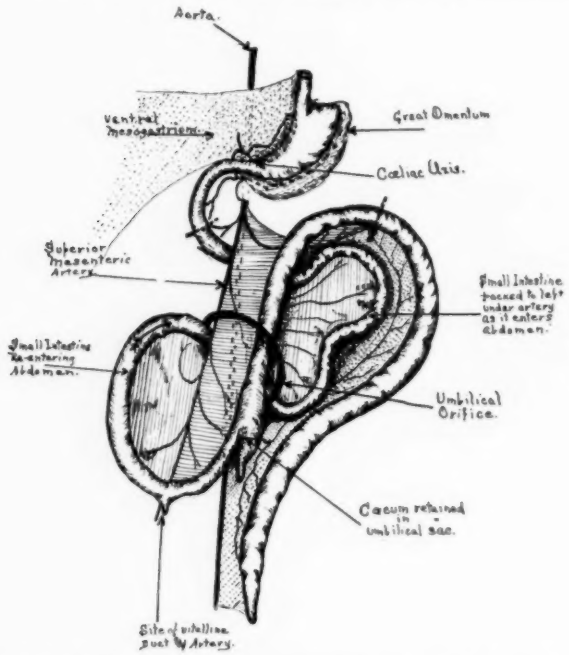

FIG. 5. Conditions of alimentary tract at tenth week. It will be seen that the pre-arterial segment of the loop—the small intestine—has increased in length disproportionately to post-arterial segment, and that its mesentery has shared its rapid growth. Cecum and adjacent colon have grown relatively thick. Temporary umbilical hernia is in process of reduction. Small intestine is seen entering abdomen on right side of superior mesenteric vessels and passing to left side of abdomen behind mesenteric vessels to fill up available space. Vessels are held forward to umbilicus by cecum, which still lies in sac. Second stage of rotation is in progress. (Copied from Dott. *Idem.*)

It does not appear particularly congested. When opened longitudinally the lumen of the appendix is seen to be patent throughout. No fecaliths are present. The wall appears to be the usual thickness. The mucosa presents a somewhat greyish surface. Sections taken for microscopic examination. Dr. Claiborn.

Microscopic. Sections of the appendix show a mucosa, the epithelium of which is absent in areas. The submucosa is infiltrated heavily with round cells and the germinal centers of the lymph follicles are large, with clear cells. The muscularis and serosa are not abnormal in appearance.

Final Diagnosis: Vermiform appendix. No pathological diagnosis. Dr. Lindskog.

The roentgenogram was made about a month after operation.

Subsequent questioning failed to elicit any history of abnormal abdominal sensation, bowel movement, or particularly any indication of

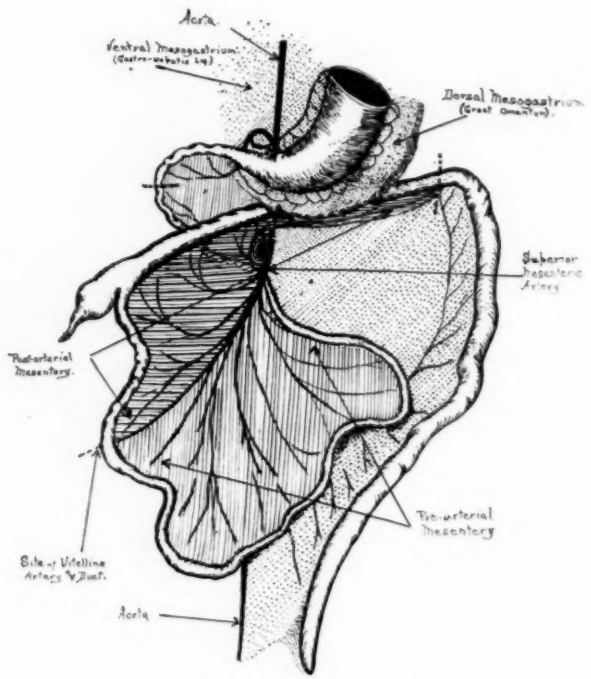

FIG. 6. Conditions of alimentary canal about eleventh week. Second stage of rotation is complete—cecum is now in contact with posterior abdominal wall in right loin. It will now be seen that midgut loop has rotated on axis of superior mesenteric vessels through 270° from its original sagittal plane. Essentials of permanent disposition of viscera have been attained. (Copied from Dott. *Idem.*)

partial obstruction. Six months after operation there was no abnormality found on physical examination.

Mayo has called attention to the possibility of determining the left-sided location of the colon by percussion. In this case knowing that the colon was so located it was possible to demonstrate an increased area of tympany on the left side with a less resonant right lower iliac area. This left-sided area of resonance varied a good deal however. Shortly after a stool it scarcely exceeded the usual limits of descending colon tympany in the average individual. When the large gut was distended the increase in the extent of this tympanitic area was quite marked, extending occasionally as far as the midline. The right iliac percussion note naturally re-

mained unchanged. As far as this particular case is concerned then, and no further (for this is the only case that I have had the opportunity to study, it appears that: the finding of an increased left-sided tympany at a single examination is more or less a matter of chance; 2, the finding on repeated examination of a variable and at times markedly increased area of left-sided tympany, below the umbilicus, associated with a constantly present relatively dull area in the normal location of the cecum in the right iliac fossa is suggestive of non-rotation of the large bowel. Definite diagnosis is readily attained by *x*-ray examination.

Lon W. Grove of Atlanta[1] reports a case in a male twenty-seven years old, with a history of abdominal pain and diarrhea, definitely related to meals, and persisting since infancy. Grove diagnosed the condition, adjusted the colon over into its normal position, and got a symptomatic cure. He does not publish the *x*-ray plates taken after operation. Presumably the anatomical situation was materially altered. He attributed the persistent symptoms to mechanical irritation caused by adhesions between the duodenum and the non-rotated colon.

Ordinarily the condition of non-rotation of itself is symptomless. There is however an increased liability to intestinal obstruction due to volvulus chiefly, and occurring in about one-half the number of cases during the first few days of life. Dott especially calls attention to this situation as a more frequent cause of intestinal obstruction in the first few days of life than is generally appreciated. Of 13 cases of malrotation in which the condition gave rise to symptoms 6 occurred in the early postnatal period; 7 developed obstruction in after years. The remaining 35 of a total of 48 cases which Dott collected, including 3 of his own were discovered accidentally. They were symptomless.

Case II. Anna C., aged sixty-five, single. Was admitted to Grace Hospital Oct. 16, 1919, with an acute intestinal obstruction of two days' duration, and a history of obstinate con-

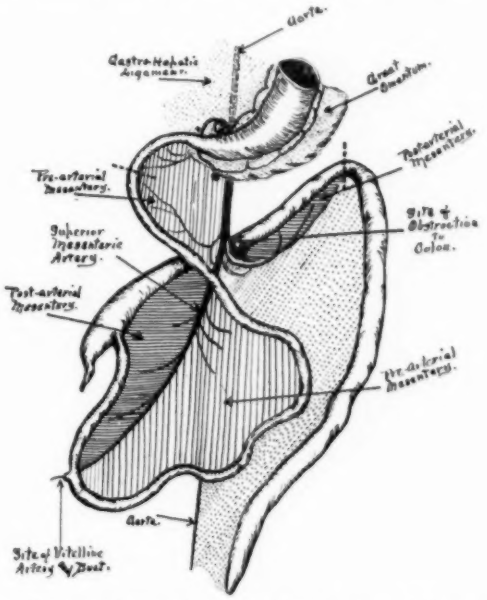

Fig. 7. Reversed rotation of midgut loop. Midgut loop has rotated in clockwise direction through 90°, from original sagittal plane. Thus colon is brought to lie behind mesenteric vessels and duodenum in front of them. These are the only noticeable defects, viscera otherwise attaining normal positions, though of course their anterior and posterior surfaces are reversed. (Copied from Dott. *Idem.*)

stipation which had existed "always," and which produced frequently recurring attacks of pain and vomiting relieved by enemata and laxatives. The site of the obstruction was found in the lower reaches of the ilium "about 2 ft. from the ileocecal valve." Here the gut was fast to the posterior abdominal wall by its mesentery of no length. The leaves of the mesentery here attached formed an arch under which the small intestine had crawled, jamming a coil of gut in the acute angle formed by the faulty attachment of mesentery to the posterior abdominal wall "to the left of the spinal column." Compression of this loop was visible and there were 4 small hemorrhagic areas on the peritoneal surface of the bowel at the point of constriction. The constriction relieved by mobilizing the deficient mesenteric attachment of the terminal ileum permitted the collapsed terminal ileum to fill readily. But it was then found that the mesentery itself was twisted clockwise through 180° or more and it was necessary that "the entire small intestine be rotated from the left to the right side"

[1] *Ann. Surg.*, 91: 615–618, 1930.

(anticlockwise) of the abdomen through 180° to accomplish "the straightening out of the mesentery." (The quotations are from my own

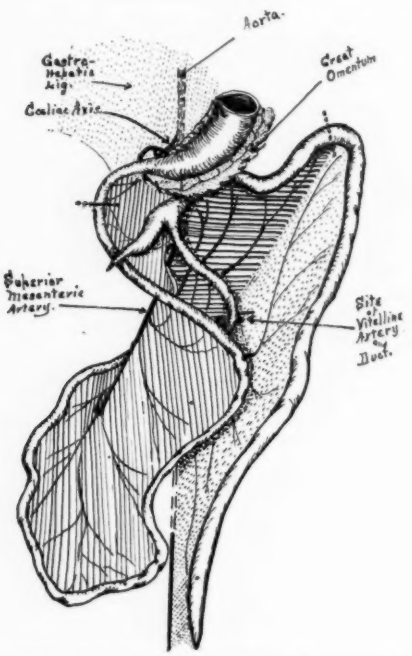

Fig. 8. Malrotation of midgut loop. Reversed rotation of pre-arterial segment through 90° in clockwise direction. Arrested rotation of post-arterial segment. Mesentery is folded over as on a hinge, at line of superior mesenteric artery. (Copied from Dott. *Idem.*)

operative records.) This case was probably an early stage of volvulus superimposed on non-rotation for at the conclusion of the operation there were small intestines lying to the right of the cecum. This patient made an uneventful recovery and some seven years later died of pneumonia. Her constipation persisted.

The accompanying diagrams together with their legends need no additional explanation to make clear the conditions obtaining in malrotation of the colon. A clear concept of these conditions would have been invaluable to me in 1919. Based thereon the surgeon confronted unexpectedly with an obviously anomalous abdomen can greatly expedite his work both in interpreting and meeting the particular indications of the problem in hand. Moreover these patients should be appraised of the existence and character of their anomaly and told that they are more likely to develop intestinal obstruction than is the general run of mankind. In this manner they are safeguarded against an unwelcome and unusual hazard of life.

Reference to the figures will make it apparent that finding himself engaged in an anomalous abdomen the operator will naturally turn his attention to two pertinent observations:

1. The relation of the duodenum to the origin of the superior mesenteric artery. Does the duodenum pass under the artery, fast to the spinal column, and is it retroperitoneal? Or does it lie free in the abdomen, with a mesentery, wholly unrelated to the origin of the superior mesenteric, and continuous with and indistinguishable from the jejunum?

2. Does the transverse colon pass under the origin of the superior mesenteric artery as in Figure 7, or does it not?

These are the key points in determining the variety of malrotation present.

It is beyond the purpose of this article to discuss the embryology or mechanics of the production of these faulty rotations of the colon. To those interested I recommend the study of the original article by Norman M. Dott of Edinburgh,[1] from which the accompanying diagrams were copied.

[1] *Brit. J. Surg.*, 11: 251–286, 1923–1924.

SPONTANEOUS RUPTURE OF THE ESOPHAGUS

FOLLOWING VOMITING*

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THE following case is reported because of its rarity and because it is interesting that serious injury to the esophagus may result from severe vomiting. Moreover, the fact that the marked abdominal symptoms present led, as in many other recorded cases, to laparotomy, should attract the attention of the abdominal surgeon. Most of the cases, in the literature, of actual rupture of the esophagus have been in men but Vinson of the Mayo Clinic[27] has reported 9 cases in which, as the result of the vomiting of pregnancy, serious damage has been done to the lower esophagus. All of his patients who recovered, developed strictures in the lower third of the esophagus. Two of them died, one from an abscess of the mediastinum and the other from an esophageal hemorrhage. Still another developed a periesophageal abscess and recovered following drainage into the esophagus. The vomiting of a dark, bloody material was a prominent symptom and most of the patients complained of a substernal pain. It is certain that Vinson's cases were the direct result of the vomiting of pregnancy. Two factors seem to have been responsible for the trouble. The first was direct mechanical trauma to the wall of the lower esophagus, which, in the case to be reported in this paper, resulted more seriously in the actual rupture of the esophagus. The second factor was described by Zenker[48] and Von Ziemsen in 1878 as esophagomalacia. It was their belief that as the result of vomiting the lower esophagus is exposed to the prolonged chemical and digestive action of stomach contents and the reaction thus induced, especially in weakened individuals, predisposes to more serious results from inflammation and trauma.

The case which led to this report was that of an active business man aged fifty.

For ten years this patient had had all the usual symptoms of duodenal ulcer. The diagnosis had been confirmed by definite *x*-ray findings. He had also had a stricture of the lower esophagus which had caused considerable difficulty in swallowing. In spite of these conditions he had been quite comfortable and had been gaining weight.

At seven o'clock on the morning of February 3, 1928, the patient began to have abdominal pain and vomited strenuously for the following two hours but was able to bring up only a small amount of blood. Suddenly at 9.00 A.M. he experienced a very severe pain in his epigastrium and left lower thorax. He was not relieved by ½ grain of morphine.

When seen at 12.00 noon he was in great distress. The whole abdomen was hard and extremely tender in the epigastrium. His breathing was difficult and he groaned constantly. He was lying doubled up on his left side with his thighs flexed. His temperature was 100°F., pulse 120, systolic blood pressure 120, diastolic 75, and respirations 30. The red blood count was 4,500,000, hemoglobin 70 per cent white blood count 8800, with polymorphonuclear cells 70 per cent. The urine showed albumin 180 mg. per 100 c.c., sugar negative, and acetone positive. Examination of the chest showed no definite pathology except what might be explained by a recent cold. There was no emphysema of the neck at any time during the illness.

In the light of a definite history of duodenal ulcer a diagnosis of an intra-abdominal perforation was made and the abdomen opened. There was no perforation of the stomach or duodenum. There was, however, a volvulus of a loop of the lower ileum causing an acute obstruction. The pylorus was markedly constricted by the old ulcer and the dilated stomach distended with about 3 qt. of fluid.

The following day he was much worse. There

* Read at the Forty-third annual meeting, American Association of Obstetricians, Gynecologists and Abdominal Surgeons, held at Niagara Falls, September 15, 1930.

was no vomiting but he was restless and in shock and perspiring profusely. He complained of pain in his chest and of labored breathing with inability to take fluids by mouth or to clear mucous from his throat. His temperature was 103°F., pulse 140 and respirations 40. There was now a definite pneumothorax on the left side and the heart was displaced to the right. The breath sounds were diminished throughout the left chest and there was fluid dullness in the left thorax posteriorly. He died at 9.00 P.M., thirty-six hours after the onset of his severe pain.

A post-mortem examination, fifty minutes after death, showed a greatly distended small bowel and a loop of gangrenous ileum. The pylorus was stenosed. The left lung was collapsed and the pleural cavity filled with a thin, brown fluid with a fecal odor. The pleura was covered with exudate and greatly inflamed. There was a stricture of the esophagus 5 cm. above the diaphragm with an internal diameter of 4 mm. Between the stricture and the diaphragm there was a complete rupture of the esophagus 2 cm. long connecting the lumen of the esophagus with the mediastinum and left pleural cavity. The fluid in the left pleura contained many gram-negative bacilli, streptococci, staphylococci and gram-positive diplococci. The right lung was completely adherent to the chest wall, effectively preventing rupture into the right pleural cavity. The patient also had a chronic interstitial nephritis and an early coronary sclerosis.

The esophagus above the stricture was normal except for one area of chronic inflammation in the submucosa. Just below the stricture there was quite normal stratified squamous epithelium but still lower toward the rupture, a denuded area with a smooth base of dense fibrous tissue showing marked chronic inflammation. Below the rupture the epithelium showed glands resembling those of the stomach but less developed. A transverse section taken at the level of the rupture showed a mucosa with glands resembling gastric glands. A little away from the edge of the rupture there was an area denuded of epithelium. The mucosa and submucosa and muscularis showed a chronic inflammation. At the edge of the rupture there was some necrosis and a deep laceration in the mucosa extending away from the rupture. The outer layers of the esophagus and surrounding connective tissue showed an acute inflammation. The cardia and fundus of the stomach showed chronic catarrhal inflammation and erosion of the mucosa and thickening of the submucosa.

The sequence of events is as follows: The primary vomiting was initiated by the volvulus of the ileum. The distended stomach could not quickly empty itself because of strictures in the pylorus and esophagus. The fluid from the stomach was therefore forced by vomiting into the lower esophagus and being unable to pass the stricture, was driven through the chronically diseased esophageal wall into the mediastinum and left pleural cavity. The adhesions of the right lung to the chest wall prevented a rupture into the right pleura. Death was due to shock, intestinal obstruction, and acute infection of the mediastinum and the left pleura.

The first case of rupture of the esophagus from vomiting was reported in great detail in 1724 by Boerhaave[5] and the second in 1788 by Dryden,[11] a military surgeon in Jamaica. Fitz[12] in 1877 reported a case and reviewed the literature to date. He rejected a number of cases, which were undoubtedly authentic, on the basis that they were due to post-mortem digestion. It has been rather difficult to disabuse the minds of the profession on this point but the occurrence of some 30 cases, since that time, under such similar circumstances and with such uniform symptoms and physical signs, has made the argument of less value. Sir Morell Mackenzie[28] reported a case in 1886 and fully discussed the subject, reviewing the cases to date. In 1900 Bowles[6] and Turner collected 18 cases and reported 1 of their own. In 1914 Irving J. Walker[40] found 22 cases including 1 of his own. He excluded 10 cases, many of which could well have been accepted. A bibliography of all cases to date is appended to this paper.

One must reject from this group cases of rupture of the esophagus from such causes as tuberculous bronchial glands, pyogenic mediastinal abscesses, carcinoma, lues, aneurysms, direct trauma from foreign bodies, diverticula, acute gangrenous stomatitis, and chemical burns.

The etiology of this accident is now clear and well established. A patient with a full

stomach vomits or retches violently and ejects fluid into the esophagus with such force and such suddenness that the pressure cannot be relieved quickly as it usually is by the escape of fluid through the esophagus. The force is therefore exerted against the walls of the stomach and esophagus, and a rupture occurs at the weakest point which is the lower end of the esophagus. Mackenzie removed the esophagus at some 18 post mortems and produced rupture by water pressure and found that rupture occurred in all but 1 in the lower third under a pressure of from 5 to 11 lb. The rent was always longitudinal, the muscle giving away first and finally the mucosa.

As explained before, it is not necessary to presuppose any obstruction of the esophagus during vomiting as a cause of rupture. In several cases, however, rupture occurred while the patient was making a violent effort by retching and coughing to dislodge a piece of meat from the gullet and in 2 cases, including the 1 reported in this paper, the accident occurred with vomiting in the presence of an esophageal stricture. The musculature of the lower esophagus is largely voluntary and that in the lower end is involuntary. It is probable that a spasm of the circular voluntary fibers of the upper esophagus during vomiting or even a lack of their coordination with the muscles of the lower esophagus might cause an obstruction during the act of vomiting. Again, the unyielding nature of pharyngeal outlet between the cricoid cartilage and the sixth cervical vertebra may be a point of relative obstruction during vomiting.

Whether an absolutely normal esophagus can be ruptured by vomiting under the conditions just described is difficult to prove because of the condition of the organ when examined post mortem. Nevertheless, in many of the cases reported there is every reason to believe that the esophageal wall was of normal strength before rupture. It is not unreasonable to believe that a pressure of from 5 to 11 lb., found necessary to rupture the normal esophagus, could result from severe straining and vomiting. Undoubtedly, the strength of the esophageal wall varies in different individuals. The organ, too, may be weakened by scars, strictures, dilatation, ulceration, chronic inflammation, such as that of alcoholism and that following prolonged vomiting and regurgitation. Fitz[12] in 1886 made the following statement: "There exists the certainty that a previously healthy oesophagus may be suddenly ruptured by muscular action."

The rupture of the esophagus may extend only into the mediastinum with acute mediastinal cellulitis or abscess formation. Usually, the tear extends through the mediastinum and pleura into one or the other pleural cavities, more frequently the left. When this occurs the lung on the affected side soon collapses and the pleura becomes the site of an extensive and virulent inflammation comparable to a general acute peritonitis. Death is largely due to sepsis from this cause. When the rupture is into either pleural cavity the mediastinum is always involved, as the path of the rupture must pass through the mediastinum. The infection of this space is therefore added to that of the pleural cavity. When the rupture is only into the mediastinum both pleural cavities usually contain bloody fluid and when the rupture extends into one pleural cavity the other shows bloody fluid at post mortem. In 1 case the pericardium contained bloody serous fluid.

The laceration in the wall of the esophagus has always been immediately above the diaphragm and longitudinal in all cases except 2. In that of Boerhaave[5] the gullet was torn entirely across just above the diaphragm and in that of Tändler[39] the laceration was transverse. The left and posterior walls of the esophagus have most often given away and the right and anterior, less frequently. The tears have been from ¾ in. to 2 in. long. The walls of the esophagus near the tears have frequently shown signs of chronic inflammation or other pathology but in many cases nothing

has been found which could not be explained by the violently acute process present in the mediastinum and pleural cavity.

The origin of the emphysema appearing first in the neck above the suprasternal notch has given rise to considerable speculation. It most probably arises from air forced into the mediastinum from the stomach at the time of rupture or from the air in the pleural cavity. It is well known that violent coughing or straining with or without tracheal obstruction may be followed by subcutaneous emphysema. The pneumothorax itself may arise from air in the stomach or from air swallowed after the accident and may therefore be delayed at times for several hours.

The victims of spontaneous rupture of the esophagus have usually been men of an average of forty-two years, often alcoholics, who during the act of vomiting or retching have experienced sudden severe pain in the upper abdomen or lower chest; most frequently in the left lower chest and back. The vomiting has always taken place after a full meal or at least when the stomach was full and nearly always some blood has appeared in the vomitus. The pain has been of a severe character unrelieved by large doses of morphine. The patients assume a sitting position stooping forward, or a similar position lying on the involved side. They do not want to lie flat on their backs as in abdominal perforations. Frequently, they relate that at the onset of their pain they had a feeling as of something tearing or giving away in the lower thorax. The patients are found in considerable shock with dyspnea and cyanosis as characteristic symptoms.

If the rupture takes place into the pleural cavity there will soon be evidence of pneumothorax, displacement of the heart, diminution of the breath sounds, changes in the expansion of the lower chest and fluid dullness. These chest signs and symptoms will not be characteristic if the rupture extends into the mediastinum only and frequently not in the first few hours when the rupture is into the pleura. Some patients complain of an increase of pain on swallowing or eructating. A peculiar symptom has been the presence of emphysema appearing first above the suprasternal notch and spreading to the chest, abdomen, and even scrotum. This symptom has been present in two-thirds of the cases reported. The patients have complained of more or less pain and soreness in the epigastrium or whole abdomen and muscle spasm has usually been present. These symptoms have led in a number of cases to a diagnosis of an intra-abdominal perforation and unnecessary surgery. The whole clinical picture is one of a serious accident to the thoracic or abdominal viscera in which profound shock and sepsis rapidly develop.

The onset of this clinical picture with vomiting followed by abdominal pain, soreness, and muscle spasm will require the ruling out of such acute abdominal conditions as ruptured peptic ulcer and acute hemorrhagic pancreatitis. However, the pain referred to the lower thorax, the marked dyspnea and cyanosis should lead immediately to a careful examination of the chest. The presence of diminished breath sounds, pneumothorax, cardiac displacement, and fluid dullness will justify a paracentesis of the pleural cavity. If stomach contents are found in the aspirated fluid a diagnosis is assured provided diaphragmatic hernia can be ruled out. The *x*-ray is of value in proving the presence of the pneumothorax, lung collapse, and heart displacement. The diagnosis of the rupture in the esophagus by means of a barium meal, although it might be conclusive, will not be practical because of the condition of the patient. In case the esophageal rupture is into the mediastinum only, an accurate diagnosis will be difficult. The *x*-ray with or without a barium meal will be helpful. An examination with the esophagoscope will suffice if the patient can be controlled. The presence of emphysema in the neck will lead to at least a suspicion of esophageal rupture.

The treatment of a case of rupture of the

esophagus, if one is so fortunate as to make an early diagnosis, will depend upon whether the rupture has taken place only into the mediastinum or into the pleural cavity on one side or the other. The rupture into the mediastinum will result in an extensive cellulitis more often than an abscess because of the force with which infected stomach contents is driven into the loose cellular tissue of the mediastinum. An abscess may be diagnosed, opened and treated through an esophagoscope but the drainage of a mediastinal cellulitis in this way will be entirely inadequate. The lower posterior mediastinum has been drained for acute mediastinitis by removing the lower ribs at the costovertebral angle on the right or left side. The operation is known as posterior mediastinotomy. The serious condition of the patient, however, will make this procedure extremely hazardous and of doubtful value. When the rupture takes place into the pleural cavity, free and prompt drainage of the cavity is imperative. In such a case, if the patient survives the infection of the pleura and the accompanying mediastinal involvement, he will develop an esophageal fistula which will probably close spontaneously. Feeding through a duodenal tube or gastrostomy will of course be required. Later, dilation of the esophagus to prevent stricture will be necessary.

RESUME

1. Rupture of the esophagus may follow vomiting.

2. Serious damage to the esophagus has followed the vomiting of pregnancy.

3. The ruptured esophagus has often been abnormal before the rupture.

4. Probably a normal esophagus can be ruptured by vomiting.

5. Rupture of the esophagus from vomiting can occur only when the stomach is full.

6. Abdominal pain, soreness, and muscle spasm suggest intra-abdominal pathology.

7. Thoracic pain, dyspnea, cyanosis, emphysema of the neck, and physical signs in the chest following vomiting should suggest esophageal rupture.

8. In rupture into the pleura, thoracotomy is imperative.

9. A case of spontaneous rupture of the esophagus following vomiting is reported.

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[For Remainder of References see p. 516.]

PERFORATION OF THE CECUM RESULTING IN INVAGINATION OF THE SMALL BOWEL INTO THE LARGE INTESTINE WITH AN ILEOCECAL INTUSSUSCEPTION WITHIN A COLIC INTUSSUSCEPTION*

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THE causes and variations in the production of intussusception are manifold. Almost all, however, can be classified and the mechanism of their production explained. The case to be presented is such that a careful survey of the literature on this subject failed to reveal one of a similar type. Its explanation must be to some extent problematical.

E. P. Female, five and one-half months old. Admitted to Harlem Hospital December 22, 1929. Died December 22, 1929.

Family History: irrelevant.

Past History: normal delivery, no previous illness, medical or surgical.

Present History: on December 16, 1929, child became ill, vomited a large amount of milk and water. Child cried loudly, fell asleep and awoke suddenly and cried again. Vomiting continued December 17 and 18, following all food intake. After December 18, child did not vomit until December 22, the day of admission to the hospital. Vomiting continued throughout the day; at first of recently ingested food, and then bile colored fluid. Bowels had not moved since December 16, 1929. Enema returns consisted of clear fluid with mucus and blood.

Physical Examination: reveals an acutely ill baby of five and one-half months.

Head: anterior fontanelle open and sunken.

Eyes: deeply set with black rings around them. Pupils dilated and equal, reacting to light.

Mouth: mucus membrane and lips dry, tongue coated and brown.

Face: cold and pale.

Neck: no retraction.

Chest: heart rapid and feeble.

Abdomen: no adenopathy, markedly distended, no rigidity, tenderness on palpation over left lower quadrant. No masses palpable. No visible peristalsis.

Rectal Examination: sphincter dilated, anus covered with a pinkish discharge. About 1½ cm. within the sphincter a hard indurated umbilicated mass can be felt. This mass extends up within the rectum as far as the examining finger can be inserted. Around this mass can be felt the rectal mucosa.

Extremities: cold.

Clinical Pathology: urine acid, albumin 1 plus, with a few hyaline casts. Positive acetone. White blood corpuscles, 14,000. Polymorphonuclears, 81 per cent. Lymphocytes, 19 per cent.

Diagnosis: intussusception.

Operation: December 22, 1929 at 6 P.M. Right lower paramedian incision. Serous fluid found on opening the abdomen. Mass felt extending from the ileocecal region to the sigmoid. Appendix and cecum cannot be seen (Fig. 1, A and B). The mass proved to be an intussusception. After the apex of the intussusception was reduced to the middle of the transverse colon, reduction was difficult. At this time the appendix, cecum, and the ileum which was severed 10 cm. from the ileocecal valve, came into view (Fig. 1 C). Through a perforation of the cecum was seen an everted ulcerated patch of mucosa, and going through this perforation was found the ileum, which was not intussuscepted but invaginated. This was reduced by gentle traction and the oral severed end of the ileum was located. There was an escape of feces as the oral end of the ileum was delivered. Simultaneously with the reduction of the intussusception to the middle of the transverse colon, two bursting rents occurred at the antimesenteric border of the ascending and transverse colon (Fig. 1 D). The condition of the child at this time was so precarious that a rapid resection of the large bowel to the splenic flexure was performed. The distal end of the splenic flexure was invaginated with a double purse string suture. A tube was inserted

*Presented to the Clinical Society, Harlem Hospital, January 30, 1930.

into the severed oral ileum, which in turn was sutured to the lower end of the incision. Routine closure with in situ and pelvic drainage.

Pathological Report: December 29, 1929. Clinical diagnosis, intussusception; source of specimen, bowel resection.

Gross Report: the specimen consists of the cecum, ascending and transverse colon with 10 cm. of ileum. There are two fresh rents, one at the antimesenteric border of the ascending colon 8 cm. in length, the other at the antimesenteric border of the transverse colon 5 cm. in length. The distal end of the colon is crushed by a clamp. The aboral end of the ileum is gangrenous and sharply demarcated. Between the ileum and the appendix is a perforation, 2½ cm. in diameter, the edges are everted, congested and swollen, with an exudate. On section an ulcerated patch of mucosa is seen just below and fusing with the lower border of the perforation.

Microscopical Examination: none made.

Progress Notes: temperature on admission 99° F., 100°F. before death. Pulse too rapid to count. Respirations 48. Two hundred fifty cubic centimeters saline clysis given at 3.30 P.M. Soapsuds enema given at 4 P.M., returned clear with particles of mucus, no blood. Five hundred cubic centimeters saline clysis given at 5.30. P.M., 500 c.c. saline clysis given at 7 P.M. Patient died at 8.55 P.M.

Comment: the exact sequence of the events which brought about this mechanism of obstruction must be one of conjecture. A possible explanation of the mechanism is given.

An early perforation of the cecum occurred. This assumption is based on the appearance of the perforation with its everted mucosa at the lower border. The area involved was hemorrhagic and covered with a fibrinous exudate. How the perforation was produced is difficult to state.

The ileum became invaginated through this perforation into the ascending and transverse colon. The blood supply to the involved ileum was not impaired except at a point 10 cm. from the ileocecal valve. Here it was severed, the result of a circular area of gangrene.

The ileum in this position in all probability acted as a tumor and caused an ileocecal intussusception. The primary ileocecal intussusception could not continue as such, as it was prevented by the invaginated ileum within the ascending colon. Peristalsis still being present, the invaginated small intestine and ileocecal intussusception continued as a single apex resulting in a true colic intussusception.

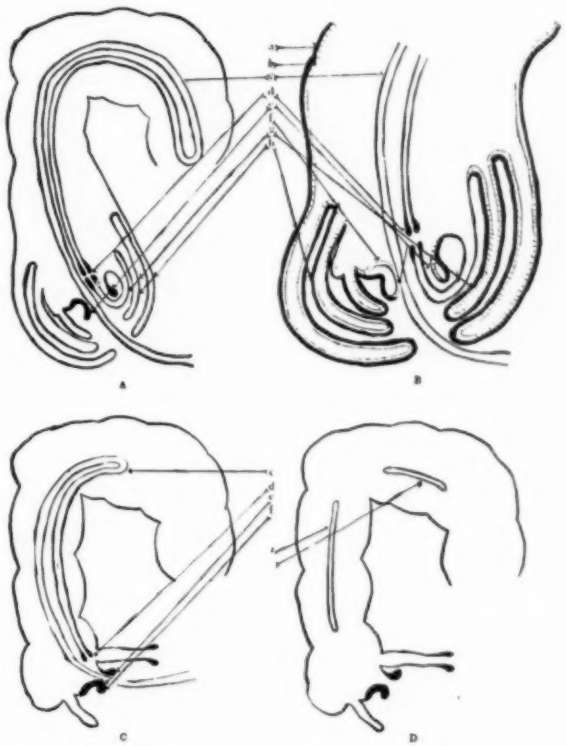

Fig. 1 A. Pathology found at operation. B. Enlargement of A., focusing upon the ileocecal region and ascending colon. a. heavy black line indicates serosa. b. cellular line indicates mucosa. c. invaginated ileum. d. areas of severed gangrenous ileum within the cecum. e. edges of perforation in cecum. f. everted mucosa of cecum, presenting itself at lower border of perforation. g. ileocecal intussusception. h. colic intussusception. C. Pathology found after apex of intussusception was reduced to middle of transverse colon. c. invaginated ileum. d. areas of severed gangrenous ileum. e. edges of perforation in cecum. f. everted mucosa of cecum, presenting itself at lower border of perforation. D. Specimen removed at operation. i. rent in the ascending colon. j. rent in transverse colon.

L-SHAPED RUBBER TUBE FOR DRAINING THE BILIARY TRACT*

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IN many operations upon the biliary tract some form of drainage is indispensable. Either the ordinary rubber catheter brought into use by Mayo Robson[1] or the rubber T-tube whose use was advised by Deaver[2] of America and by Kehr[3] of Germany is usually employed in draining the common and hepatic bile ducts.

When a catheter is used a soft, pliable one should be chosen. It can have numerous lateral eyes to facilitate the internal and external drainage of bile. The fenestrated end of the catheter is placed in the bile duct pointing towards the liver. The bell end of the catheter passes through the incision in the duct and the incision in the abdominal wall. The chief disadvantages in the use of the catheter are that it cannot be fixed securely in the bile duct for prolonged drainage, and that scar formation and stricture may result from damage done to the duct wall by the anchorage sutures. As the catheter cannot be bent at at a right angle without obliterating its own lumen, it must lie in a long curve that allows it to slip out of the bile duct. Leakage of bile round the catheter sometimes occurs when after a few days the tube becomes loosened. Strong sutures must be used to fasten the catheter in place. There is considerable tugging and pulling at these sutures which may result in tearing the duct walls. In the healing which follows such as injury scar tissue may be formed, and contraction of this scar tissue may lead to a stricture of the bile duct.

The rubber T-tube ensures free internal drainage of bile and prevents back pressure in the liver by allowing external drainage if the bile cannot flow through to the duodenum. The T-tube remains in position when it is placed in the lumen of a bile duct, and the duct wall can be closely sutured about it. There are, however, two important disadvantages in the use of the T-tube; first, that its removal frequently causes damage by tearing the wall of the bile duct; second, that when an attempt is being made to pull the T-tube out of the wound the stem may break off leaving the transverse portion in the duct. Stricture of a bile duct has followed the use of a T-tube when the duct wall has been torn during the removal of the tube. As the portion of the T-tube projecting through the abdominal wall is pulled, tension is exerted through the stem of the tube on its transverse portion which is pulled upwards at its center against the opening in the bile duct. The force necessary to draw the double arms of the T-tube out of the drainage opening could easily dilate the opening sufficiently to cause the soft and friable walls of a healing duct to collapse, or the force might be great enough to split the duct transversely for more than half of its circumference. The tearing and subsequent healing of the duct wall would result in a scar which might later contract and cause a partial or complete occlusion of the duct's lumen. Kehr,[3] who frequently used the T-tube in his operations on the biliary tract, tried to prevent the tearing of the duct walls by cutting off one end of the transverse portion to ½ cm. Kehr[3] also discovered in his use of the T-tube that its early withdrawal tore out the sutures which had been placed in the choledochotomy wound. McArthur[4] and others have reported that stricture sometimes occurs following the tearing of the duct wall during the removal of a T-tube. It should be borne in mind that any form of bile-duct drainage may predispose to stenosis, and that infection in the fistulous tract may also cause necrosis and sloughing of the duct wall with subsequent stenosis. Therefore the catheter or T-tube cannot be blamed for every case of stricture which occurs following their use. Not only may

* Submitted for publication January 19, 1931.

the removal of a T-tube injure a duct wall, but when the stem of the tube is being pulled it may break off and leave the transverse portion in the bile duct. When this happens it becomes necessary to operate upon the patient in order to remove the transverse portion of the T-tube from the duct. This accident happened to Kehr[3] in one of his early cases and it has also happened to others (Fig. 1).

In order to overcome the disadvantages of the ordinary rubber catheter and the rubber T-tube I have devised an L-shaped rubber tube for draining the biliary tract. The L-shaped catheter provides a means of both internal and external drainage of bile, it can be securely fastened in a bile duct for temporary or prolonged drainage, and it can be easily removed at any desired time without injuring the duct wall. The L-shaped tube is a catheter with 2 in. of its end bent almost at a right angle. This bent portion of the tube has six eyes to facilitate drainage, one in the tip, one in the elbow, and four placed laterally. The L-shaped catheter is made in sizes 16 and 18F., which we have found best suited for drainage. When the L-shaped catheter is to be used to drain a bile duct the short, bent portion of the tube, which can be cut off to any desired length, is inserted into the duct through a choledochotomy wound or through a small slit made in the duct wall above or below a reconstruction. The tip of the catheter can therefore point either downwards towards the duodenum or upwards towards the liver. The fenestrated portion of the tube which lies within the duct prevents swelling or edema from occluding or constricting the lumen of the duct, and in the case of a reconstruction supports the line of suture. This fenestrated portion of the tube also supplies a means of through-and-through drainage of bile. Should there be a temporary obstruction which prevents bile from flowing into the duodenum it can drain externally through the long portion of the tube which passes through the slit in the duct wall and out of the abdominal wound.

When the L-shaped catheter has been placed in position in the bile duct the opening of the duct is tightened about it

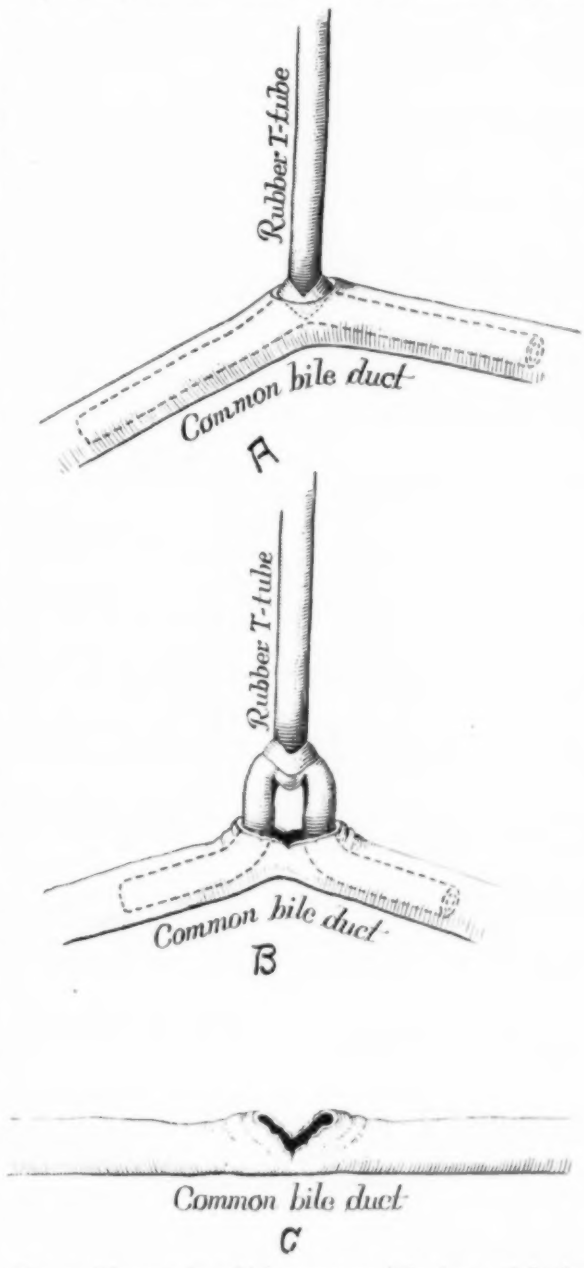

Fig. 1. Manner in which common bile duct might be damaged in withdrawing a rubber T-tube. A. Showing opening in common bile duct being dilated and duct being pulled upwards when tension is made on stem of T-tube to withdraw it. B. Showing relative amount of dilatation necessary to pull two arms of T-tube through drainage opening. C. Showing common bile duct torn transversely by force exerted in order to bring both arms of T-tube through opening in duct wall.

by suture. After the suture is knotted it is wound about the catheter to hold the tube securely in the duct. The bell, or

funnel, end of the catheter is brought out of the upper end of the abdominal wound. To hold the catheter in the abdominal wall and to prevent its being pulled out after the operation, a silkworm suture may be fastened into the skin which can include the external sheath of the rectus muscle. The suture ends should be wound about the catheter and tied. To hold the catheter in position after the wound was healed, two strips of adhesive plaster may be placed along opposite sides of the tube and extended outwards on the skin. It has been found that better results follow when drainage is maintained for a considerable time. The drainage tube should be left in place for several weeks or several months depending upon the conditions which were found at operation and the character of the bile flowing through the tube during convalescence. Before the drain is removed it should be clamped off for two or three days to make certain that bile is flowing into the duodenum. The L-shaped drainage tube can be removed by traction being made on that portion which projects out of the abdominal wound. The tube will then slip out easily without tearing or dilating the opening in the duct. The small drainage opening through which the tube passed usually heals quickly (Fig. 2).

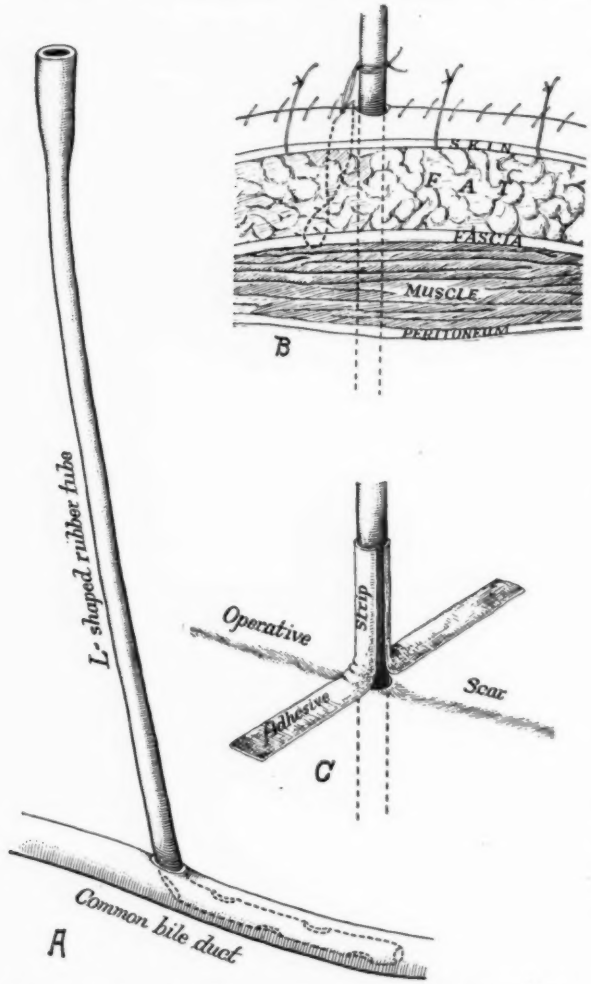

FIG. 2. L-shaped rubber catheter for draining common bile duct. A. Showing L-shaped rubber catheter in common bile duct. It will be noted that the eye in the elbow and the one in the tip of the L-shaped catheter provide a means of continuous flow of bile when there is no obstruction in the duct. It will also be noted that the lateral eyes in the L-shaped catheter will facilitate external drainage if there be an obstruction. B. Method by which L-shaped catheter can be held in place with silkworm suture during first two weeks after operation. C. Method by which L-shaped catheter can be held in place with adhesive straps after wound has healed sufficiently to remove sutures.

ADVANTAGES OF THE TUBE

1. It can be introduced easily into the common or hepatic bile duct.
2. It can be placed with its tip towards either the liver or the head of the pancreas.
3. It has an opening at the tip and one at the elbow, making a communicating channel from the upper portion of the bile duct to the lower for the continuous passage of bile.
4. It has four lateral eyes to ensure drainage in case the opening in either end becomes plugged.
5. The bell, or funnel, end provides a means of external drainage if an obstructing mass or edema prevents internal drainage.
6. Drainage can be maintained by holding the catheter in place with a silkworm suture during the first ten days or two weeks, and later with strips of adhesive.
7. The catheter can be withdrawn easily without damaging the duct wall.
8. There is no danger of breaking off a portion of the tube during its removal.

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GALL-BLADDER DISEASE*

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MAPLEWOOD, N. J.

CHRONIC infection of the gall bladder, with or without the presence of stones, is of fairly frequent occurrence. Its recognition is not difficult and the importance of proper treatment generally appreciated. A series of 65 cases treated surgically at the Orange Memorial Hospital, during the past three years, has demonstrated some interesting conditions and taught some valuable lessons. The result of this experience and the observations made, form the basis for this discussion of the subject.

The diagnosis of gall-bladder disease is usually apparent from a fairly consistent clinical history. The familiar syndrome of, "indigestion" flatulency, belching of gas, epigastric distress; accompanied by recurrent attacks of pain in the upper right quadrant of the abdomen, radiating beneath the scapula, indicates gall-bladder pathology. The discomfort varies in degree from merely a sense of fullness, to severe colicky seizures, requiring an opiate for relief. There may be nausea and vomiting and an attack may be followed by jaundice. The usual type of individual is one who is inclined to an excess of fat, about forty to fifty years of age, women being more frequently attacked than men, the average being 3 to 1. Deaver aptly expresses it, "fair, fat and forty." There were 60 women and 5 men in our group, the average age being forty-six, the oldest seventy and the youngest nineteen.

In addition to the given symptoms, the greatest aid to correct diagnosis is cholecystography. The information obtained from an *x*-ray study, after the method developed by Graham, which consists in the employment of the dye, sodium tetraiodophenolphthalein, either orally or intravenously, is of great value. The concentration of this dye within the gall bladder, delineates its contour, demonstrates irregularities and shadows, and the rapidity with which the gall bladder empties after a fat meal. The failure of the dye to enter the organ indicates an obstruction, from some cause, either in ducts or ampulla; all of these are factors upon which deductions as to the condition of the gall bladder, may be made.

In a recent article,[1] Kirklin of the Mayo Clinic, reports that correct diagnosis may be made in approximately 90 per cent of cases. He also states in a series of 287 cases, that the oral method proved as satisfactory as the intravenous. Most of our recent cases have been radiographed and the roentgenologist's report substantiated. Some of the patients, with typical clinical histories, have been operated upon, without previous *x*-ray study.

In an interesting paper recently read before this society, Dr. Reitter discussed this aspect and he reported a high percentage of positive findings; of 70 cases coming to operation, the diagnosis was confirmed in all but 3. The present method of administering the dye has been satisfactory in our experience. Cholecystography has been the means of a better knowledge of the physiology of the gall bladder. It has been shown to be the storehouse for the reserve supply of bile, a place for its concentration and its regulated supply. The gall bladder is full during fasting and empties its contents during active digestion. In the absence of the gall bladder, some of its function is assumed by the ducts and it has been well established that an individual may enjoy good health in the absence of the organ. The experiments of Rous, McMaster and Aschoff[2] indicate that the

[1] Kirklin. *Coll. Pap., Mayo Clinic*, 1929, p. 136.

[2] Rous and MacMaster, The concentrating activity of the gall bladder. *J. Exper. Med.*, 33: 731, 1921.

* Read before The Orange Mountain Medical Society, December 19, 1930.

chief function is that of a regulator of bile supply.

The study of the blood is of value in the cases of acute gall-bladder infections, just as it is in infections elsewhere; a leucocytosis indicates the relative degree of infection, the development of suppuration, etc. The estimation of bile pigment content of blood serum is a help in determining an obstructive jaundice. The indirect quantitative method of van den Bergh is probably the most reliable. This depends upon the presence of bilirubin in the blood: high concentration would indicate an obstructive jaundice. The icterus index test when showing a stationary or rising curve, would indicate the existence of an obstructive jaundice. The van den Bergh test was used in some of our cases, to determine whether the jaundice present was due to obstruction or to a hematogenous cause.

The causative factors of gall-bladder disease are somewhat uncertain, but the factor of infection plays the chief rôle. The organ may harbor the ordinary bacteria of infection in its walls: stasis with poor drainage; the presence of stones, which irritate the mucosa of the lining, just as any foreign body furnishes ideal conditions for both acute and chronic inflammation. The existence of pregnancy predisposes to disease of the biliary tract, because of the great increase of cholesterol at this time, and the disturbance of cholesterol metabolism is an important etiological factor, as has been emphasized by Whipple.[1]

The excessive ingestion of fats, such as olive oil, may have some bearing on the frequency of its occurrence in Italian women. The existence of a chronic appendicitis, in conjunction with cholecystitis, is a frequently observed occurrence. The factors of this relationship are not definite. Graham states[2] in its consideration, that the most plausible connection between the two organs is by the lymphatics, rather than by the blood stream, through the liver. In our series, evidence of the existence of definite disease of the appendix was demonstrated in 37 cases, or 56.9 per cent. We have made it a rule to remove the appendix in all cases where feasible, and in which there were no contraindications. In 2 cases, small fibroid, string-like atrophied appendices were left in situ. In one man his appendix could not be demonstrated. In 5 cases, because of the serious condition of the patient, the appendix was not examined. In Judd's series at the Mayo Clinic, chronic appendicitis was found in 31 per cent. The appendix had been previously removed in 19 cases, or 29 per cent. It has not been possible to determine whether an examination of the gall bladder was made in all of these cases at the time of original operation, but the frequency of this occurrence is an argument for careful examination of the gall bladder in all cases.

The treatment of gall-bladder disease by biliary drainage after stimulation with magnesium sulphate, has been extensively employed. Vincent Lyon developed a technique which was claimed to be effective and which is still employed by some internists. It undoubtedly has been effective in some of the cases of chronic cholecystitis with stasis and without calculi. Four of our cases were so treated, without relief. It is our opinion that chronic cholecystitis and colelithiasis are surgical conditions. Many individuals may have gallstones without active symptoms. In operating upon patients for other conditions, their presence may be discovered. Autopsies reveal the presence of stones in subjects who gave no history of such disease. Nevertheless, the presence of stones in a gall bladder or ducts, offers a definite menace to an individual's well being and sooner or later, clinical symptoms become apparent. The typical manifestation of presence of calculi, is the occurrence of colic, which happens more often when small calculi are being forced

[1] Whipple, A. O. Pathogenesis of lesions of biliary tract. Nelson's Loose Leaf Surgery, page 467.

[2] Graham, Cole and Copher. Disease of gall bladder and bile ducts, page 117.

into the ampulla or ducts. Stones vary in size from a millet seed to an egg; may be single or the entire gall bladder be filled. The composition varies from the simple cholesterol calculus to those containing a large proportion of calcium, which gives a more definite shadow in the *x*-ray films. In our 65 cases, calculi were found in the gall bladder alone, in 33 instances, 51 per cent; in the gall bladder and cystic duct in 7 cases; in the common duct in 5 cases, 9.2 per cent; in the hepatic duct in 1 case, 1.5 per cent. There were evidences of chronic infection of the gall bladder with thickening, discoloration of the walls, sections showing pathological changes in 31 cases, 47.6 per cent, in which there were no calculi. In one group comprising 14 cases, there were firm, well organized bands of adhesions between the gall bladder and the duodenum, stomach and liver. These cases were all attended by symptoms suggesting the presence of calculi and yet none were found. One case showed an hour-glass contraction at the middle of the gall bladder. In one there was a broad band of adhesions from the fundus of the gall bladder, encircling the pylorus and distorting the cap. Some of these adhesions may be congenital bands, such as are known to occur elsewhere within the peritoneal cavity, a fact which has been emphasized by Dr. Alfred Taylor of New York. Radical treatment of these cases is followed by a complete relief of symptoms.

Where the cystic duct is obstructed by calculi, the gall bladder becomes functionless and in 3 cases, Mrs. T. No. 41, and Mrs. F. No. 59, and Mrs. H. No. 57, hydrops developed, the organ distending to four times the normal size. Usually the stones can be gently milked back into the gall bladder from the cystic duct; but where impacted, the duct should be incised and the stones removed. The duct should be thoroughly exposed and clamped well above its entrance into the common duct, for it is in this procedure that many of the accidents occur, which are followed by scar tissue deformity and obstruction of the common duct. In 1 case, Mr. M., a patient of Dr. Hunt's, a cholesterol stone, the size of a marble, had become impacted in the cystic duct and ulcerated partly through the wall; there were also calculi in the gall bladder in this case, which were not demonstrated by the *x*-ray. An uneventful recovery and relief of symptoms followed his operation.

Prior to the time of the present series was the single case of hepatic duct obstruction which was instructive. The history of this patient was as follows:

Case 1. Mrs. M. aged forty-one, had frequent attacks of gallstone colic from 1916 until the date of her first operation, January 24, 1921, at which time a large number of gallstones were removed and the gall bladder drained, the appendix being removed at the same time. She remained well for eight months, when epigastric distress and flatulency returned. One year after the operation, she had an attack of colic similar to original seizure; such attacks occurred at varying intervals until January 19, 1924, when she was reoperated upon, for suspected gallstones. None were found but the gall bladder was buried in adhesions and the cystic duct sharply kinked. The gall bladder was removed. In separating adhesions, a small duct, apparently a branch of the hepatic, was injured with a leakage of bile following; drainage was established and except for the development of a cystitis, she made an uneventful recovery, remaining well until July 7, 1925, one and a half years after the second operation. At this time she had an attack of jaundice lasting two weeks; this was followed by intermittent attacks until they became persistent in November. Common duct obstruction was suspected from a calculus which had not been discovered. On December 11, 1925, the abdomen was re-opened, common duct found patent without stones; a stricture of hepatic duct was found 1½ in. from entrance into liver; the duct was incised and two firm masses of inspissated bile removed, a free flow of bile from the upper end of duct obtained; a small rubber tubing, 2 in. long, was introduced into duct, after surrounding adhesions were freed, the tube having a strong linen thread attached, which was drawn out through the wound. The duct was sutured and the area

covered with omentum, drainage tube inserted and abdomen closed. She made an uneventful recovery, the tube was removed through the abdominal wound on the twenty-sixth day. There was a small amount of bile leakage for two days. She left the hospital on the thirty-eighth day and has been in excellent health since.

There have been 5 cases of stone in the common duct in our series. Calculi in the common duct may be overlooked and it is important to search carefully for their presence. This should be done by free exposure of the duct, to give good visualization and careful palpation. If the history be suggestive, and there be any doubt, the duct should be explored by probe or small rubber catheter. If the stone be small, it may be delivered through the cystic duct, or if impacted, through an incision directly over it. One of our cases, No. 2, Mrs. H., had a calculus in the ampulla of Vater. It was necessary to mobilize the duodenum by incising the parietal peritoneum, rotating inward, thus exposing the common duct down to its entrance into the duodenum. In cases where symptoms persist following cholecystectomy, the possibility of a common duct stone should be considered. One of our cases, Mrs. S., who was operated upon on October 8, 1929, stones being found in the gall bladder and cystic duct, has had a recurrence of pain; there has been no jaundice or severe pain and careful *x*-ray study reveals nothing, but she may have a small common duct calculus.

Some cases of common duct obstruction from stricture, are those in which some form of difficulty has been encountered at the original operation; for example, in the attempt to control hemorrhage, the hepatic or common duct may be grasped by forceps and a contraction occur following the application of a ligature. The cutting of the cystic duct too close to the common may be followed by a contraction at that point. There were 3 cases of common duct obstruction from stricture. One interesting case of common duct obstruction was reported at the hospital clinical meeting.

Case II. This was an Italian woman fifty-one years of age, on whom a cholecystectomy was done December 1, 1928. Her abdomen was closed without drainage and had to be reopened on the seventh day for leakage of bile from remnant of cystic duct. She was discharged as cured January 6, 1929, and remained well until November, 1929, when she became jaundiced, which condition steadily increased until January 28, 1930, when at operation a stricture of the common duct at point of entrance of cystic duct was found. A T tube was introduced, the jaundice clearing promptly and she was discharged as improved on February 22 with tube in situ. The tube remained, with the patient in good health, until May 12, 1930, nearly four months, when it was removed. In July, two months after its removal, intermittent attacks of jaundice began to occur, becoming deep and persistent during the first part of September. On Sept. 27, 1930, further exploration revealed a contraction and constriction of the lower end of the duct, from scar tissue, the lumen being practically obliterated at the point corresponding to the portion of the lower limb of the T tube. The upper part of the duct being patent, it was dissected free and sutured into the wall of the duodenum, around a T tube, one end of which projected into the lumen of the duodenum and the other short end upward into the duct, the whole being then surrounded by omentum, a tight anastomosis having been made. The jaundice disappearing entirely in two weeks, the patient left the hospital with the tube in situ, on October 29, one month and two days after operation. She has remained well, with normal bile in stools, since. This tube may be removed and replaced by an indwelling plain tube, which can be discharged through the intestine later. However, this patient was in good health during the four months in which the T tube was within the duct, from January to May; partial obstruction occurred from contraction of the scar tissue at the point of exit of T tube, within two months after its removal and complete obstruction after four months. Her normal supply of bile has now been restored to the duodenum, by means of the anastomosis reinforced by the tube dwelling within this anastomosis.

My plan has been to leave the tube in situ for an indefinite time, so long as the patient remains well and then remove it when a well organized fistulous tract may have time to form. A very comprehensive article on the sequelae of the gall bladder infections by Dr. Deaver, in the *Journal of the American Medical Association*, November 29, 1930, cites some very interesting observations, one of which will be quoted.

Just one word about T tube drainage. The mucous membranes are very tolerant to rubber. The retention catheter, for example. I had one patient, who wore a retention catheter for fourteen years and he remained perfectly well. If the urethra is tolerant to a rubber tube, why not the common duct? Some of my patients wear the T tube indefinitely with equal tolerance. One woman wore one for *four* years. Then I had great trouble getting her to let me take it out, because three operations done previously were followed by recurrence.

This gives me great comfort in my management of the case in question.

Case III. The third case of common duct obstruction was a woman, Mrs. C., operated on May 3, 1930. Her gall bladder had been removed in 1923 and her health had remained good for four years or until 1927, when she had her first attack of jaundice. The periods of jaundice became more frequent and of longer duration and on her admittance she was deeply jaundiced. At operation the stump of cystic duct was found adherent to under surface of liver. The T tube being left in for two weeks, the jaundice disappeared promptly and she made a good recovery and has remained well since.

Case IV. One other case, Mrs. F., No. 18, operated upon May 22, 1928, was closed without drainage and had to be re-opened on the sixth day for biliary leakage. The patient developed a pleurisy with effusion and was in the hospital for twenty-six days. She made a good recovery and is today in good health.

Eighteen cases were closed without drainage and of these, 2 cases had to be re-opened. This was due to some error in technique on our part. Possibly the ligature on the cystic duct slipped, but such an accident should not occur; if it should, a drain would preclude serious complications. In the *Annals of Surgery*, September, 1930, Saunders reports the end-results in 500 cases of cholecystectomy. In 172 cases or 34.4 per cent, the abdomen was closed without drainage. It was not necessary to re-open the abdomen in a single case, nor had there been evidence of leakage of bile into the peritoneal cavity. Richter of Chicago was one of the first to advocate closure in these cases. Many cases can undoubtedly be closed with safety, but the patient's best interest is assured by the introduction of a small rubber catheter drain, which can safely be removed on the fifth day, the wound being well healed by the twelfth or fourteenth day. This is the routine practiced at the present time.

We believe that cholecystectomy should be the procedure of election. A gall bladder which has been drained and left in situ, may be the seat of further calculus formation, does give symptoms from adhesions and increases the likelihood of further surgical complications. There are certain conditions, such as an acute gangrenous gall bladder, empyema of the gall bladder with jaundice and patients who are very poor surgical risks, in whom cholecystostomy should be done, because as in other acute emergency operations, within the abdominal cavity, our aim should be to afford relief to a serious condition, with the least possible risk to the patient. Operations upon the gall bladder and ducts are serious and should be approached with proper conception of what is to be done and due appreciation of the technique of its performance. Our method has been to remove the gall bladder from below upward, first exposing the ducts thoroughly; ligating the cystic artery separately, thus enabling the cystic duct to be put on a stretch and carefully ligated; the dissection being carried upward leaving the peritoneal margins on either side of the sulcus of the liver and closing all raw surfaces. Subserous dissections from above downward is a good procedure, but does not afford as good as an exposure of the cystic artery.

The choice of anesthesia is of importance.

In the majority of cases, a spinal anesthesia is the method of election. It gives a far better relaxation, with wider exposure, a reduced respiratory excursion of the diaphragm, less distention of the intestines, requiring fewer abdominal packs. In this series there were 31 spinals, 32 generals, 2 avertin anesthesia. Avertin alone or with a supplementary of gas oxygen, is satisfactory; but in our experience, spinal anesthesia greatly reduces the difficulties in gall-bladder surgery. Sodium amytol was used in conjunction with spinal anesthesia in 6 cases. It affords the great advantage of having the patient anesthetized in the room, avoiding any of the impressions or memories of the trip to the operating room. It has the added advantage of a longer postoperative sleep.

Cass v. The case of Mrs. J., aged sixty-seven, one of the first of our cases to be done under a spinal, was gratifying because of the unusual history. In 1919, her appendix was removed by a New York surgeon; in the course of his examination, a gall bladder with many stones was discovered. Because of her poor behavior under the anesthesia, her gall bladder was simply drained. In 1925, she was re-operated for suspected stones by a Chicago surgeon. His version of the operation is as follows: "adhesions from the fundus of the gall bladder to duodenum, producing a Harris kink, were found and freed, as were adhesions from the liver to the diaphragm, the thickness of a lead pencil. There were no stones in the cystic, hepatic or common ducts. It was my intention to remove the gall bladder, but tension on gall bladder, stomach or liver, produced a respiratory paralysis; the patient stopped breathing for over a minute: this did not occur only once, but *five* times on the table, the patient stopped breathing; consequently we found it absolutely impossible to remove the gall bladder." Under spinal anesthesia, a gall bladder buried in adhesions was easily removed and this woman, who was a chronic invalid, has been entirely well for the past three years.

The average length of time in the hospital was 20.8 days, the longest being sixty-four days in a patient, a nurse, who was a chronic invalid, who developed a phlebitis and who was more happy and comfortable in the hospital than in her apartment. The shortest length of stay was eleven days.

In the treatment of acute cholecystitis, unless there is evidence of rapidly spreading and severe gall-bladder infection, conservative treatment is indicated. The acutely inflamed gall bladder will localize the infection more readily than an acute appendix. If the condition shows evidence of spreading or increasing in severity, as shown by elevation of temperature and blood count, surgery should be resorted to at once and this is one of the conditions in which drainage rather than removal of gall bladder may have to be resorted to. However, if the condition be confined to the gall bladder and there be not excessive edema of the gastrohepatic omentum, in the region of the ampulla and ducts, cholecystectomy should be the method of choice. Each individual case should be decided upon the basis of the condition found, the guiding attitude always being the employment of the procedure, which gives the patient the best assurance of a permanent relief.

Of the four deaths in this series, one, Mr. D. No. 8, was a case of perforated gangrenous gall bladder. His condition was grave throughout and he died of a terminal pneumonia. Mrs. B. No. 38, developed a lobar pneumonia on the tenth day, the interval being uneventful; her death occurred thirty-seven days later or forty-seven days after operation. The general and cardiac condition of this patient was poor; the possibility of empyema was suspected and she was seen by a number of physicians. Autopsy revealed an unresolved lobar pneumonia, with small serous pleural effusion. The site of the gall bladder removal and peritoneal cavity and liver was normal. Mrs. K. aged sixty-one, No. 63 was a case of common duct stones, who died in twenty-four hours of surgical shock. She was in poor condition at the time of operation. Mrs. M. No. 21, aged forty-one, three months pregnant,

had a perforated gangrenous gall bladder with general peritonitis. She died on the ninth day from general sepsis paralytic ileus, and one other case, Mr. D. No. 52, was a case of partial intestinal obstruction from a carcinoma of the sigmoid. This man had an acute gangrenous gall bladder with calculi and was critically ill. His gall bladder was in such a condition that it was deemed safer to remove it than to drain it. When the gall bladder was removed, the existence of a neoplasm of the colon with obstruction was not known. This was discovered in completing the examination of the intestinal tract. A colostomy was performed. He died on the tenth day from paralytic ileus.

A morality of 6 per cent is far too high for cholecystectomy. There have been no deaths in the uncomplicated chronic cholecystitis and cholelithiases cases. Our other patients have all been followed up and are in good health.

SUMMARY AND CONCLUSION

First: Many cases of persistent, so-called intestinal indigestion, are due to chronic cholecystitis.

Second: Cholecystectomy is the operation of choice for acute and chronic cholecystis and for gallstones. Due importance should be given to the proper technical performance and possible postoperative complications.

Third: When the operation is properly performed the mortality in uncomplicated cases should be low.

Fourth: Proper medical supervision and dietary control should be part of the postoperative treatment.

Fifth: Careful search of the common duct for calculi may prevent some of the failures.

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*Continued from p. 458.

CANCER OF THE BREAST IN THE MALE*

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CANCER of the breast in the male is rare and of all the cases of breast cancer in the Radiation Department of Bellevue Hospital treated during the past six years, only 3 per cent were in the male breast.

FIG. 1. Case IV. Healed scar and good movement of the arm.

Although the cause of cancer still remains unknown, irritation has been considered a most important predisposing factor. If this factor can be considered in the production of carcinoma of the female breast where nursing and regular periodic hormonic stimulation takes place, such a factor is entirely irrelevant as a cause in producing carcinoma in the male breast.

Marked change in function with rapid proliferation and regression during pregnancy, often repeated, and atrophic changes following the menopause may offer some explanation for the more frequent occurrence of carcinoma in the female breast.

FIG. 2. Case I. Marked edema of the right arm.

Until puberty the male and female breast develop alike and are embryologically of the same origin. After puberty the female breast undergoes a marked change along with the development of other sex characteristics, while the male breast remains quiescent.

Cases of Paget's disease of the male nipple have been described by several authors. Forrest in 1880 made the first clinical report of Paget's disease in the nipple and areola associated with carcinoma of the breast with lymphatic metastases in a male. Williams in a series of 2422 breast neoplasms found 25 in men

* From the Radiation Therapy Service, Bellevue Hospital, Division of Cancer. Dr. Ira I. Kaplan, Director.
Submitted for publication January 28, 1931.

Table I

Case	Age	Nationality	Duration	History of Injury	Breast Involved	Glandular Involvement	Operation	Family History	Pathological Diagnosis	Remarks
I	64	Hebrew	10 years	None	Right	Axilla and supraclavicle	Radical 1917	Negative	Scirrhous	Developed edema of right arm 7 years post-operatively. Died in 1926.
II	65	Christian	8 years	None	Left	Right and left axillas	Simple mastectomy, 1924.	Negative	Scirrhous	Died from pneumonia March, 1930.
III	47	Hebrew	1 year	None	Right	Right axilla	Radical 1926.	Negative	Adenocarcinoma	Died from pleurisy with effusion 1927.
IV	43	Christian	3 years	None	Left	Left axilla	Radical April 1928, March 1929.	Negative		Living and well. Reports to the clinic for periodic examination and observation regularly.
V	50	Hebrew	1 year	None	Right	Right axilla	Radical March and July 1930.	Negative	Adenocarcinoma	Living and well. Reports to the clinic for examinations regularly.
VI	35	Christian	6 months	None	Right	Right axilla	Simple excision. June 1930.	Negative	Adenocarcinoma	Reports to the clinic regularly. Complains of pain in the back and spine. Roentgen examination shows no evidence of metastasis in spine or pelvis.

of which but 16 proved to be carcinoma. Elbogen in 1908, observed a typical clinical case in a man forty-eight years old with a tumor in one breast and metastatic nodules under the skin of the opposite breast and the corresponding axilla and where about seven months after radical amputation had been performed enlarged lymph nodes appeared in the supraclavicular fossa associated with pulmonary symptoms and a marked degree of debility. The patient died shortly afterwards and the histological picture of the tumor removed at operation was that of an adenocarcinoma of the breast, with the so-called Paget's cells in the epidermis.

Jonas in 1910 reported a case in a male patient in whom the nipples and areolae of both breasts were involved, and histological studies showed carcinoma invading both breasts. Sekiguchi in 1917 referred to a case in a man sixty-seven years of age with ulcerated Paget's disease involving the nipples and areola. Warfield in his series of 307 cases of carcinoma of the breast found 3 in males. Judd and Morse of the Mayo Clinic report a series of 1757 cases of which 17 were in male patients.

The time of occurrence of the tumor in the breast of the male and female has been variously reported. In males the disease occurs a few years later than in the female and Blodgett reported the occurrence of carcinoma of the breast in a boy aged twelve, and Bryan reported one at the age of fourteen years and eight months.

The oldest in our series was sixty-five and the youngest thirty-five years. From the racial standpoint 3 were Jewish. The known duration of the tumor before operation is variously stated as from one to three years. In our series of 207 cases of breast carcinomas 6 were male and 201 were female. The average duration in the 6 male cases was six years.

The symptoms exhibited were pain, retraction of the nipple and ulceration, and the extent of these varied with the type, situation and extent of the carcinoma just as in carcinoma situated elsewhere in the body. All 6 cases had glandular involvement.

In 4 of the 6 cases here reported a radical operation was performed. In 2 cases only local excision of the tumor was done. Deep *x*-ray therapy was given post-

operatively in all cases. Three patients are living and report to the clinic regularly for periodic examinations.

Results: Three patients are living and three are dead. The average length of life after operation was six years. The three living patients report regularly to the clinic for periodical examinations.

In our opinion the *x*-ray therapy administered following operation hindered the further growth of the disease and helped prolong the life of the three living patients. From our observation in these cases, we believe it is equally advisable to irradiate carcinoma of the breast in the male, as it is in the female.

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*Continued from p. 501.

STONES IN THE BILIARY DUCTS*

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GALLSTONES usually form in the gall bladder but they may form primarily in the ducts. Hydrops of the gall bladder usually means a stone blocking the cystic duct or stricture resulting from a stone which has been there and passed on out or fallen back.

Etiology: A stone has a nucleus which may have been bacteria such as the colon or typhoid bacillus or the pus organisms; it may have been a clot, epithelium, or crystals; it may have been a cast of a duct; or it may have been the so-called catarrh of the ducts with mucus formation.

Cholesterosis or lithogenous catarrh or gallstone diathesis is thought to be of etiological importance. About 70 to 80 per cent of a stone is cholesterin; the rest is organic matter and lime salts. Another factor to be considered is obstruction to free drainage. Cholesterosis is usually a middle-life condition although stones may form at any age. It is much more frequent in women; possibly pregnancy has some bearing. Most patients are over forty years of age. A man's liver is larger and may have protective function against infections, etc.

Catarrhal affections predispose to stones by causing the infection and thereby the stagnation of bile. Large eaters are often affected. Those passed middle life who do not exercise are apt to suffer.

Anatomy: The gall bladder normally is about 2½ to 4 in. long and about 1 in. in diameter. The cystic duct is 1 to 1½ in. long and less than ¼ in. in diameter. The hepatic duct is about 1 in. long and ¼ in. in width. The common duct is about 3 in. long and ¼ in. or slightly more in width. About half of the duct is above the duodenum and half behind it. A short transverse vein crosses the common duct in the lower portion of the supraduodenal part.

Pathology: Coplin,[5] in speaking of cholelithiasis says:

> Their most common location is in the gall bladder; they occur in the ducts in the following order of frequency: cystic duct; cystic and common ducts; common duct; cystic, common and hepatic; intra-hepatic ducts. Beer doubts whether there are over 150 cases of intra-hepatic cholelithiasis on record.

Jaundice means obstruction. In 80 per cent of cases of stone in the common duct the gall bladder is contracted. Loss of body weight is due to infection, pain, restricted diet, loss of sleep, etc. When stones form from some of these causes they affect the ducts and with infection of the ducts symptoms more or less characteristic are produced.

The right hepatic duct is more often involved than the left, and the common duct is more often involved than either one or than the common hepatic.

Poor drainage is produced by infection and the latter in turn may be causative of the former.

A diseased gall bladder may be any size within the abdomen. The common duct may dilate to cystic proportions and the short transverse vein on the lower part may be enormously enlarged and deceptive.

Examination of the stool after a subsided colic may be of value in finding the stone if passed.

The number and shape and type of stones vary according to time, duration, infection, general condition and location of stones.

Stones are frequently found post mortem. Stones are apt to form in the hepatic ducts if stones are present in the common duct and the latter is causing obstruction and its accompaniment, infection. Da-Costa[1] in quoting Robson says the common duct is involved in 1 out of 5 or 6 cases of

* Submitted for publication January 5, 1931.

gallstone disease. Stone may lead to catarrhal or suppurative affections. It may lead to bowel ulceration and obstruction.

Symptoms: The symptoms vary according to location and according to whether the stone is accompanied by infection. A stone in transit gives pain. It may lodge. Involvement of neighboring organs may modify or add to the symptoms.

Symptoms occur only when a stone is in transit, when infection occurs or when deficient drainage occurs.

There is usually a past history of indigestion with constipation, flatulence, epigastric distress or pain, tenderness, maybe vomiting, and inability to eat certain foods.

When the stone begins to move pain is violent. It starts suddenly and is apt to end suddenly. If a stone in the ducts come from the gall bladder there will be a history of previous colic with or without jaundice.

The pain may cease gradually in the case of duct stone. Jaundice usually follows within from one to two days, but may be slight or absent even in common duct stones. Bile appears in the urine and the stools are apt to become clay-colored. Itching of skin often occurs. The jaundice is not apt to be deep because the stone does not cause complete obstruction; it is apt to vary from time to time.

Charcot's fever may occur wherein an attack of colic is followed by chills, sweats and fever. It is usually of short duration. It means infection. If it is true Charcot's fever, it is the steeple type of fever and intermits and usually is due to common duct stones. If the smaller hepatic ducts become involved there is apt to be a fever which does not intermit.

Diagnosis: A case of a patient with past history of periodic colic, jaundice, fever, vomiting, clay stools and bile in the urine who now has colic accompanied by jaundice, Charcot's fever and signs of or followed by infection, presents little difficulty in the diagnosing of biliary duct stone. It is the atypical cases that need differentiation.

Stone in the gall bladder is apt to have worse colic, to start and stop more suddenly, to be of briefer duration, to have no jaundice or clay-colored stools, to have no fever, and to have no itching.

Cancer of ducts or head of pancreas is apt to have deeper and more intense jaundice, less pain, no Charcot's fever, dilated gall bladder, itching, clay-colored stools and clinical wasting with signs of malignancy (and later cachexia).

Gastric and intestinal affections usually have no jaundice, and are not as a rule accompanied by such violent pain.

Kidney stone shows no jaundice, may have urinary changes, has different pain radiation (in the back, down the ureter and into the testicle). Cystoscopic examination and *x*-ray locate this stone.

Tabes has no jaundice, has eye sgins, tabetic gait, crises, vomiting which is usually relieved by morphine, positive blood reactions and evidences of past lues.

Cirrhosis of the liver has small liver, apt to have mild icterus, may be ascites, enlarged spleen, low bromsulphalein test, urobilin in urine (stones apt to have bilirubin in urine).

In the diagnosis of stones the *x*-rays are valuable. They may not show the stone but should always be used. The Graham dye tests are very valuable.

There is jaundice and its degree is estimated by the van den Bergh test and icterus index.

Prognosis: Stones in the common duct are more serious than if in the gall bladder and hepatic duct stones are probably more serious than either. Early treatment spares the liver and pancreas a great deal.

Treatment: When stones once form very little can be done outside of radical surgery. Diets are of no value except to put the physical condition at a better level and perhaps help reduce chances of new stones forming.

During an attack of colic morphine and atropine should be given freely and in large doses. An enema should be given. Heat to the gall bladder region is usually acceptable to the patient.

If improvement follows it is best to wait for interval operation and put patient in best condition possible. The present attack in most cases will subside in a few days.

Early operation is comparatively safe. In cases where improvement is not noted in a reasonable time surgery must be undertaken, but, as stated, where improvement occurs under treatment it is wise to temporarily postpone the operation and prepare the patient.

In a short time the fever usually abates, the jaundice partially or nearly clears, pain markedly abates, vomiting stops and the patient makes a marked clinical "come back."

Preparation for operation further consists in measures to combat postoperative hepatic toxemia and hemorrhage. The ingestion of fluids and carbohydrates including sugar and glucose in large amounts for several days before operation combats more or less the former while 5 c.c. of 10 per cent $CaCl_2$ intravenously daily for three days before operation reduces the coagulation time and helps prevent postoperative bleeding.

The local preparation, etc., is carefully done. A right paramedian incision from costal cage to near umbilicus is probably best. Moynihan advises turning rectus out. A thorough exploration is made after opening belly. Adhesions are usually met around the gall bladder and are cautiously freed after packing off thoroughly. When the stones have been found in the ducts they must be dealt with and the question of cholecystostomy or cholecystectomy depends on the condition of the patient. The gall bladder is practically always diseased and where the condition of the patient permits it is a good thing to remove it. The common duct is usually dilated and may look like the portal vein. A small needle on a syringe will soon identify the duct if necessary. The duct usually can be told by the palpation of the stones. The common duct is incised over the stones, avoiding the transverse vein, the stones are removed and the duct explored with probe or finger up and down for further stones. (A stone low down may be pushed or worked up and got out through incision in supraduodenal part of duct. If one is unable to get it up then retroduodenal or transduodenal choledochotomy will be necessary.) After one has removed stones from the supraduodenal part of common duct a gauze strip should be passed to wipe out any sand that may be present or saline may be injected and some of it washed out. If stones are in the hepatic duct they can usually be got through this incision in the common duct by milking the duct with the left hand while a finger of the right hand inserted high up in duct is slowly withdrawn to make a suction, or by use of the small stone scoops. In cases where stones in the hepatic duct cannot be brought down they must be removed by incision.

Drainage of the ducts must always be done. A rubber tube is placed up into the hepatic ducts through the incision and the wound in the duct closed around the tube and the tube fastened into duct by a suture of catgut. A drain is then put down to the kidney pouch and to the region of the ducts and the wound closed.

The drains are removed in forty-eight hours. The tube in the duct will loosen in from ten to fifteen days and can be removed.

CASE REPORT

C. C. Pain in the gall bladder region.

Family History: Mother died of influenza in 1918. Father well. Three brothers and six sisters all living and well.

Past History: No history of childhood diseases. Had influenza in 1918 with normal recovery. Has never had typhoid, pneumonia or other serious illness. Has never had any serious injury. He was operated upon in 1927 and apparently exploration only was done. He has had two courses in typhoid prophylaxis.

Present Illness: Trouble first began suddenly in 1927 by a pain in the upper abdomen accompanied by vomiting and fainting. He immediately went to the hospital. He suffered

pain more or less for three weeks. Two days after admission he developed jaundice. He was operated upon and exploration only done. The trouble at that time gradually subsided. Previous to the attack he recalls no symptoms of any moment. Since then he has had more or less dyspepsia and has had seven or eight attacks up to now. He has suffered them out at home.

On his admission pain is marked and severe over the gall-bladder region, epigastrium, and in the right shoulder region. There is fever, slight tint in conjunctiva, dark colored urine and vomiting. Morphine needed for pain. There are no other gastrointestinal symptoms. There are no urinary, respiratory, cardiac, or nervous symptoms elicited. He has lost about 5 lb. weight from his normal.

P. E. A well nourished adult colored male showing evidences of marked pain in the abdomen, sweating, vomiting, and a slight icteric tint to eyes and mucosae. There is extreme restlessness and anxiety. The pupils are normal. The teeth are dirty but not decayed. The tonsils are chronically diseased. There is no other pathology in the head and neck. The heart shows no enlargement, murmurs or abnormal sounds. The rate is essentially normal but respirations are 30. There are no chest findings except impaired resonance and diminished breath sounds at right lower chest. The signs are not definite of fluid. There is no inequality of expansion.

The abdomen is somewhat rigid over epigastrium and right upper quadrant. A sense of resistance suggests a mass in this region. It is tender. Murphy's sign is definitely elicited. The abdomen is not distended. There is nothing abnormal noted in the extremities except a fracture of the middle of the right fifth metacarpal bone, which gives comparatively no pain on account of the severe abdominal pain.

The fracture was reduced and splinted and morphine and atropine were given hypodermically and a hot water bag placed over upper abdomen and a snapsuds enema given. The next day the pain was markedly less but was still present. No more morphine was needed. The second day showed jaundice. A fat free diet was given. Gradually the general condition improved and on the fourth day the pain entirely stopped. The fever was not of the Charcot type. It was as shown by the fever chart suggestive of hepatic involvement. The fever also subsided after the fourth day. The respirations dropped to normal after the subsidence of the pain.

The urine was negative on admission except for darkness of color and when the jaundice deepened on second day the urine contained a great deal of bile and the stools were light in color. The sedimentation time was 18 mm. in ninety minutes. The white blood count was 20,900 with 84 per cent polymorphonuclears, 2 eosinophiles and no stippling of the red cells. The Kahn test was negative. The stools were positive for Ascaris. *X*-ray of chest failed to show any fluid but some mottling suggestive of old pulmonary trouble.

A few boils developed which caused delay in operating. He was admitted November 17 and operated on December 13. During this period the teeth were cared for, the diet regulated, carbohydrates were plentifully given and plenty of fluids were taken. The worm treatment was also given during this interval. The three days before operation $CaCl_2$ in 10 per cent solution was daily given in 5 c.c. doses intravenously. The coagulation time on the morning of operation was three minutes, reduction of four minutes from admission date, The icterus index this same time was eighteen.

Operation: The usual preliminary local preparation was given. No cathartics were used and the bowel was emptied the night before and the morning of operation by a soapsuds enema. A hypodermic of morphine and atropine was given one-half hour before and ether was the anesthetic used. A right paramedian incision turning the rectus out was employed. Upon the opening of the abdomen numerous adhesions were found between the omentum, gall bladder, common duct, stomach, duodenum and hepatic colon. The gall bladder was enormously enlarged; it contained nearly a pint of fluid and extended about to the crest of the ilium. The adhesions were slowly and with difficult separated. A small area of the pelvis of the gall bladder was adherent to the common duct. In separating the omentum from the gall bladder by gauze stripping a small rent was made in it but as the area was well packed off no soiling occurred; the small amount which spilled was caught by a pack which was in Morris's pouch. A hemostat was placed so as to close this rent. An examination revealed an otherwise normal duodenum,

stomach and colon. The kidney was normal. The liver seemed a little enlarged and the pancreas head was a little firmer than normal. It was decided to open the common duct and as the patient was in good condition and the gall bladder was badly diseased and enlarged a cholecystectomy was done at this stage by ligating the cystic artery and the cystic duct. After removal of the gall bladder the bed was closed over with a running stitch. This gave good access to the duct. With a needle the duct was explored to make sure that the portal vein was not being opened as the adhesions had somewhat distorted structures. With the left hand the stones could be felt and were grasped and an incision made on the top and to the right in the supraduodenal region. Two large stones were removed from the duct and with the finger of the left hand on the outside and the index finger of the right hand inserted in the duct stones were felt in the hepatic duct and both its branches. None could be felt downward in the retroduodenal region. By milking the duct with the left hand and creating suction by withdrawal of the right index finger a stone was removed from the hepatic duct. A scoop inserted upward removed a stone from each branch of the hepatic duct. After this no more stones could be felt either outside or inside of the biliary tract. A stone searcher was passed both up and down. The ducts were then wiped out with a strip of gauze and considerable sand was removed. A little saline injected into the ducts washed out some more. A tube was inserted up into the hepatic duct and the wound closed in the common duct around this tube. A stitch as an anchor of the drainage tube was inserted in the common duct. The omentum was placed over the area, a drainage tube put down to the kidney pouch and operative area and the wound closed in layers. Dressings were applied, saline was given by vein and the patient returned to the ward and the tube was connected to a bottle fastened to the side of the bed. Proctoclysis of glucose and soda was started. Saline by vein was again given during the night. In the morning the condition did not seem as good as desired so glucose was given by vein.

There was considerable drainage of bile through the tube and it contained a good deal of brick dust sediment. After ten days the fever left entirely and the drainage tube loosened from the duct and was removed. For two days after this dressings had to be changed very frequently but in a week the drainage had practically stopped from the wound and the stools began to get some color to them.

The patient was discharged January 23, 1930. The wound was completely healed, there was no drainage of bile, the stools became normal in color, jaundice disappeared, there was no pain or indigestion, the icterus index became normal, the sedimentation time became normal and the urine was free of bile.

At the present time there is complete freedom of symptoms and a gain of 10 lb. in weight.

CONCLUSIONS

1. Stones in both branches of the hepatic duct, the main hepatic, and the common duct accompanied by hydrops of the gall bladder without a stone or a stricture in the gall bladder are not a commonly reported condition.

2. The gall bladder is usually contracted when stone is present in the common duct. This case showed a strawberry gall bladder and hydrops but no cystic duct stricture or stone.

3. It is possible that the enlarged gall bladder may have formed at some time in the past when a stone may have been in the cystic duct and later passed on into the common duct and enlarged there; or the uppermost stone in the common duct may have been movable up and down and blocked the opening of the cystic duct into the common.

4. The salient features in etiology, pathology, symptomatology, diagnosis and treatment of duct stones are summarized and a case reported which if not unusual is not common.

5. Pain in the right upper abdomen, violent in type which is followed in a day or so by jaundice suggests stone in the common duct. When there is infection and the fever is more or less continuous and not of the Charcot type, it points to infection of the hepatic duct.

6. The obscure chest signs and the absence of subdiaphragmatic abscess leave the enlarged liver of hepatitis worthy of mention.

[For References see p. 528.]

THE IMPORTANCE OF A CAREFUL MEDICAL HISTORY IN DISEASES OF THE RECTUM*

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WHILE the importance of a minute examination of the patient, in toto, and of his perineum and rectum, in every patient complaining of rectal symptoms, is paramount, it should not be forgotten that a careful history will add much to a knowledge of the pathology which is present. Too often we are prone to take the leading symptom as indicating a certain condition which we then may find during the examination of the patient. If we had inquired further into the history we might have been led to suspect some deep-seated or masked pathologic process which far overshadowed in importance the one which caused the prominent symptom.

Thus, a patient may complain of excruciating pain coming on after each bowel movement, leading the doctor to look for an anal ulcer, which he may find. Appropriate treatment of the ulcer will eliminate the pain and the patient will go forth happy only to turn up later in another doctor's office with, perhaps, a carcinoma. A careful questioning of this patient would have elicited some information that would have led to an examination of the sigmoid and the discovery of the malignancy.

A case in point was Mr. O., a newly married man. The patient was twenty-eight years of age, and complained of bleeding during his bowel movements and of a slight pruritus of the anus. There was nothing in his medical history or his habits of much importance from a medical standpoint except that he was very fond of water and drank a great deal of it during the course of a day. This fact, combined with the knowledge that he had some anal itching, led to a request for a urinalysis which report showed that his urine was loaded with sugar. The piles, which were causing the bleeding, were unimportant compared with the diabetes and, as his means did not permit him to visit two physicians at the same time, he received two injections of quinine and urea hydrochloride, 5 per cent solution, to control his hemorrhoidal bleeding, and he then was placed under the care of an internist.

Many women complain of pain in the rectum and, if the statement is accepted at its face value, the proctologist will be puzzled to account for it in some cases. All of the usual causes for ano-rectal pain may be investigated and found absent. Here careful interrogation of the patient may determine that the pain is not in the rectum but is a coccygodynia. This is particularly true in a class of patients of low-grade mentality such as one is most apt to meet in a hospital clinic. Often women in hospital dispensaries will complain of pain in the rectum when they mean that they have backache. Again, lower abdominal cramps during defecation may be ascribed to the rectum. Rather generally there is a deficient knowledge of medical nomenclature among the laity and one must always remember that the word rectum may really mean the buttocks when used by one who is not familiar with medical terms.

The history of rectal bleeding should be gone into most thoroughly. What is the character of the bleeding; is it a free flow or merely a stain on the paper when the patient cleanses himself? Is it bright red in color or partially digested? Is it blood alone or is the blood mixed with mucus or with pus or both? Is the bleeding in definite relationship to bowel movements or entirely independent? For how long has this symptom persisted? All of these queries should be made and will give clues to the diagnosis or to the area deserving most thorough investigation. The gastroenterologist will think first of the hemor-

* Submitted for publication February 24, 1931.

rhage coming from the sigmoid or colon; the proctologist's initial thought will be of the rectum. It must never be forgotten that in any given case, blood may be coming from both areas.

In many ways the diagnostitian is a detective, running down clues until he solves the mystery. Like the detective, he may find misleading clues or there may be interlocking mysteries and he must be on his guard against jumping to a conclusion that seems obvious but is erroneous. A few days ago a negress in a hospital clinic received a diagnosis of gumma of the rectum because she had a four plus Wassermann reaction and a mass in the rectal wall. The doctor was misled by the positive Wassermann reaction so that he did not make the obvious and true diagnosis of rectal abscess.

The history of protrusion may lead one into error. Frequently the patient considers external hemorrhoids or skin tags as protrusion and he will say that it cannot be replaced. Overlooking the evident pathology will lead one to believe that there is a protrusion from the bowel which cannot be induced at the moment. If the patient is quizzed about the nature of this symptom, the misconception will not occur.

The symptom of pruritus or itching needs close consideration. Many sufferers from pruritus ani have an etiology far removed from the site of the trouble and sometimes this may be discovered through a good history. In another article[1] the writer cited the case of a banker whose itch became worse when any local measure was attempted. It was found that the symptom made its appearance or was aggravated whenever he was worried over business and it could be controlled by sedatives given by mouth. In every case of pruritus ani and particularly in those where no local cause can be found, a careful history may lead one to the discovery of some major pathology such as a diseased appendix or gall bladder or even a carcinoma of the large bowel or elsewhere.

[1] Smith, F. C. Pruritus ani. *M. Times*. December, 1929.

It should be borne in mind that rectal symptoms may occur in genitourinary disease when the rectum is not involved, due to the close relationship, both embryologically and anatomically, between the two tracts. Pelouze[2] tells of the case of a man who complained of a sensation in the rectum as though a bug were crawling there. After he had been unsuccessfully treated by a proctologist, a pus pocket was found in the posterior urethra and, when this had been evacuated, the unpleasant sensation disappeared. This patient had had a gonorrheal urethritis eleven years previously. Two years before he noticed a slight discharge of pus from the meatus and concomitant with this the crawling sensation in the rectum. If this history had been elicited by the proctologist, that gentleman would have been saved some embarrassment.

Recently the author was called upon to treat a woman with a typical postanal ulcer. The history showed exposure to a gonorrheal infection and smears from the anal pus revealed innumerable, intracellular, gram-negative diplococci. Without this knowledge the ulcer would have been excised in the ordinary course of treatment and the patient would have been subjected to the grave danger of a gonorrheal arthritis, which so often follows traumatism to the tissues in the presence of a Neisserian infection.

For years it has been the author's practice to have a printed history form. Under the heading of pain there are the following subdivisions: For how long; character; location; time at which it occurs. Bleeding, protrusion, swelling, itching, discharge, etc., follow with similar subdivisions. The medical history contains a list of diseases that may be checked off or after which notes may be made and there is a space for previous operations. By following this form salient points in the history will not be forgotten or omitted and the doctor will have a good foundation for beginning his examination.

[2] Pelouze, P. S. Gonococcal urethritis in the male. Page 301, Saunders, 1929.

NEW METHOD OF TREATING CHRONIC ULCER OF THE LEG*

I. S. TUNICK, M.D., AND DAVID H. KLING, M.D.

NEW YORK

VARICOSE veins give rise to two types of chronic ulcers of the leg. The first type develops in areas surrounded by either small or large superficial veins. The pressure of the stagnating blood atrophies, stretches and eventually ruptures the skin. Frequently a thrombophlebitic process develops, spreading the infection and causing erosion of the surface of the skin and ulceration. The most effective treatment for this type of ulcer is the obliteration of the surrounding veins by injections, which was popularized in this country by Tunick, McPheeters, G. deTakàts and others. Also the compression of the veins and the protection of skin by an Unna boot gives good results. The second type of ulcers develops in a sclerosed area, in which the skin has been damaged by a previous thrombophlebitis. There are no more visible or palpable veins in the surrounding area. The injection of the veins and supporting bandages therefore are of little or no avail. The breaking up of the sclerosed tissue and a fresh supply of nourishing material is needed for the healing of these ulcers. It occurred to one of us (Tunick), that this could be accomplished by injecting the sclerosed area around the ulcer with normal saline solution. In this paper we shall review the pathogenesis and describe the technique and the therapeutical results in 25 cases.

PATHOGENESIS

The skin surrounding the ulcer is cyanotic and discolored: it is hard and cannot be raised from the base due to loss of elasticity. This change extends either over a part or the whole circumference of the limb, depending upon the extent of previous thrombophlebitis.

Histological Findings (Fig. 1): The horny layers are deficient; nucleated cells reach the surface of the epidermis (paraceratosis). The germinative layer is irregular and increased to several rows. The rete pegs are hypertrophied in some places; in others only a few layers of epidermis are present and the corium reaches almost to the surface (acanthosis). The intercellular spaces of the epidermal cells are enlarged (spongiosis). The cutis shows thick fibers and infiltration with round cells and blood pigment as a result of old bleeding. The elastic fibers have disappeared or are greatly diminished. Grave changes have taken place in the blood vessels. The back pressure from the large veins is carried through to the subpapillary branches and capillaries. The minute veins are dilated, thrombosed, and degenerated. The walls of the capillaries are fibrotic or infiltrated (Fig. 2). They have lost their contractility and elasticity. The circulation in the skin is broken down, the metabolic processes are disturbed, and therefore the resistance to infection and trauma is highly diminished.

The pressure is further increased where the skin covers bony structures. For this reason most ulcers are found over the tibiae and inner malleoli, although the skin over the whole circumference of the leg has undergone atrophy and sclerosis, in the majority of the cases. Under this pathological condition a slight injury, scratching, infection due to poor hygiene, or local phlebitis are sufficient to destroy the skin and produce ulceration. The extent and depth of the ulceration are variable, but all ulcers have in common a diminished healing power, the tendency to recur and chronicity.

* Submitted for publication February 19, 1931.

As long as the destruction of integument is still progressing, the ulcer is covered by a slough consisting of detritus and leucocytes. The bacterial flora is mixed. We found staphylococci, streptococci, micrococcus, tetragenous, and gram negative bacilli, in the surface of the ulcer, and gram positive anaerobic bacilli in the slough (Fig. 3). None of these organisms is etiologically important. Usually they do not invade the deeper tissues. Progressive infection, lymphangitis or sepsis are therefore rare. The low virulence seems to be caused by the very same pathological processes which prevent the ulcer from healing, that is, the lack of nutrition. The characteristic appearance of the ulcer is fully developed, when an equilibrium is reached between the destructive and reparative processes, and the ulcer has become chronic. No noticeable improvement takes place for months or even years. The base of the ulcer is covered with glassy thin granulations, which do not reach the surface. The edges therefore are abrupt, bluish, irregular, and infiltrated. The extreme degree of fibrosis is best realized when we try to penetrate the ulcer with a needle in order to inject the physiological saline: the resistance we meet feels as if we are penetrating through cartilage, or better yet, hard rubber.

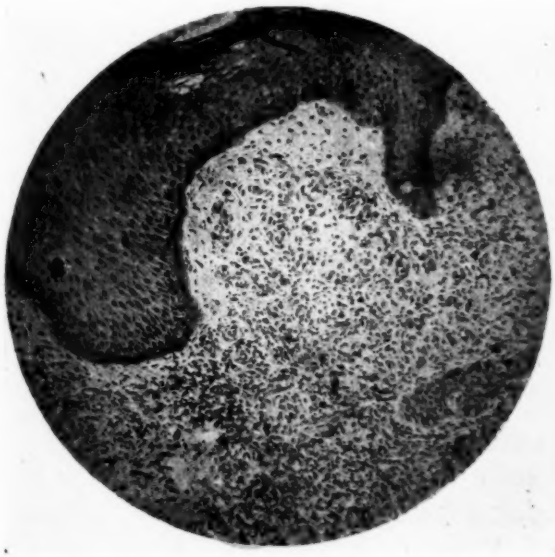

Fig. 1. Sclerosed skin surrounding ulcer, showing paraceratosis, acanthosis, and spongiosis, of epidermis, and infiltration fibrosus of corium.

Fig. 2. Enormous thickening of walls of capillaries and occlusion.

In microscopic sections (Fig. 4) the surface of the ulcer appears to be covered with necrotic material which is infiltrated by leucocytes. In recent cases abscesses with large numbers of bacteria and extravasations of blood are seen in places. The

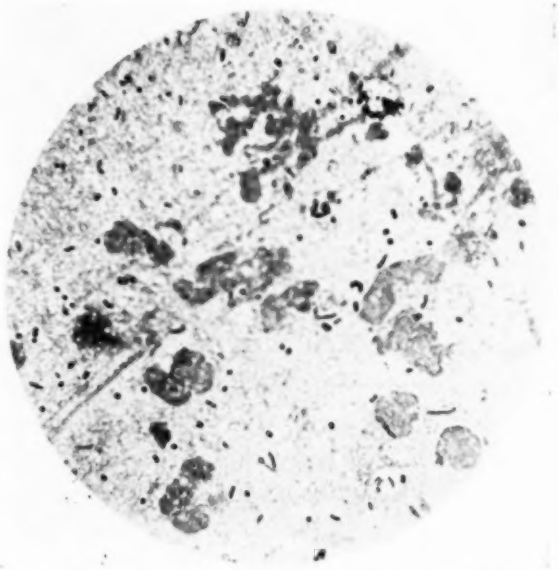

Fig. 3. Smear from chronic ulcer, showing pus cells and mixed flora of cocci and bacilli.

granulations are rich in fibroblasts, plasma, and round cells. The capillaries have undergone the changes which are characteristic for the sclerosed surroundings. The capillaries are thickened, infiltrated, and thrombosed. Normal granulations undergo a continuous reduction until they are transferred into a resistant, fibrous scar, poor in cells and blood vessels. Ulcer granulations, on the other hand, are fixed at the first stages by the premature sclerozation and thrombosis of their blood vessels. They remain infiltrated with cells, and their capillaries do not undergo reduction. The metabolism is disturbed, the healing process is arrested.

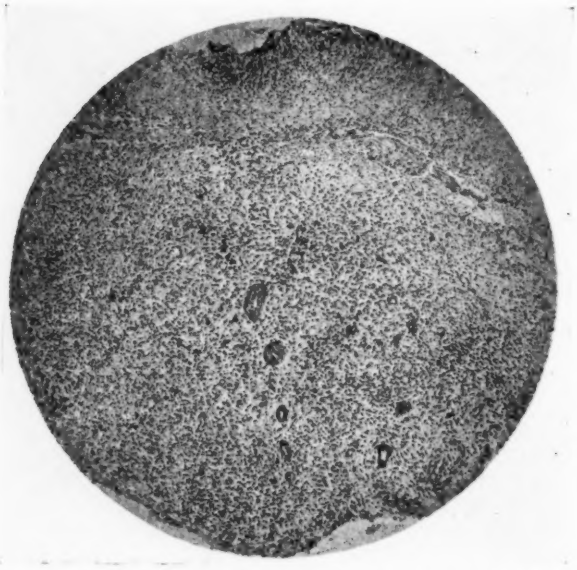

Fig. 4. Chronic ulcer, showing slough on surface, infiltration of corium, thickened and occluded capillaries.

PRINCIPLE OF THE INJECTION TREATMENT WITH NORMAL SALINE

Our analysis has revealed that the ulcer is surrounded by a thick ring of fibrotic tissue which shuts it off from the normal blood supply, from the rest of the body. This conception points the way for the therapy. We must break up the fibrotic ring surrounding the ulcer in order to permit formation of new blood vessels to properly nourish the diseased ulcerated area. When this is accomplished healing progresses very rapidly.

TECHNIQUE

Ulcers which are covered with dirty necrotic material and pus, and whose surrounding area is red and inflamed are first treated by a few days rest in bed with local application of mild antiseptic wet dressings, e.g., saturated solution of boric acid, Burrow's solution 1–4. As soon as the surface is fairly clean we start with the injections. The ulcer and its edges are painted with 2 per cent mercurochrome or with a weak tincture of iodine solution. A 5 to 10 c.c. Luer-Lock syringe is then filled with physiological salt solution. Twenty-two or twenty-three gauge 1 in. or 1½ in. needle is employed. The injection is started at the edge of the ulcer; the needle is inserted until it passes the resistant fibrotic area (Fig. 5). The solution is slowly injected and continued while the needle is gradually withdrawn. If the ulcer is large, its entire circumference should be injected at about ¼ in. intervals. The amount of solution injected varies from 2 to 10 c.c. depending upon the size of the ulcer and the surrounding fibrosis. In the beginning this procedure is frequently painful and it is advisable to anesthetize the ulcer with 2 per cent novocaine solution into the edges for the first two or three treatments. Considerable force will be found necessary in order to penetrate through the sclerosed area. Very little bleeding will be noticed from the needle puncture, in the beginning of the treatment, but after two or three treatments new blood vessels and granulations begin to form and bleeding becomes free. The treatment is repeated every three or four days until the ulcers begin to heal. The number of injections varies with the size and chronicity of the ulcer and with the extent of fibrosis in the surrounding area. During the treatment the ulcer is dressed with a bland ointment or sterile vaseline dressing. After the ulcers are healed we advise the patient to wear a supporting bandage for a few months. The healed scar of these ulcers is very strong and firm, and does not easily break

down. Sloughs produced by the sclerosing method of treatment of varicose veins are very difficult to heal. Pathogenesis

and forty; 18 (72 per cent) were in patients over forty years of age. One patient was ninety-five years. In only 2 cases did we

Fig. 5. The technique.

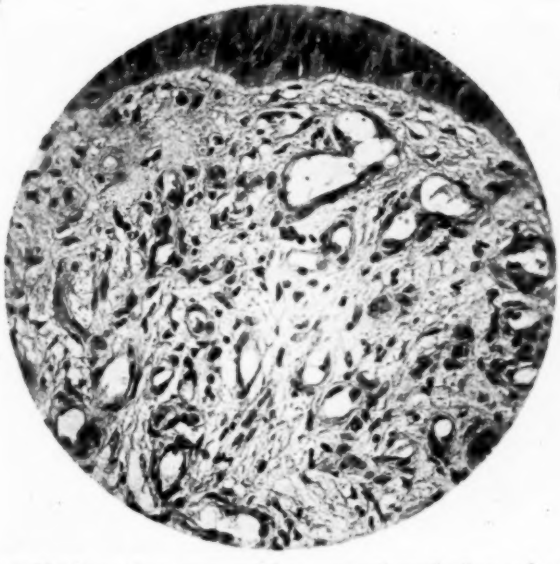

Fig. 6. Healing ulcer, covered by seam of newly formed epithelium. Numerous normal new capillaries with thick walls.

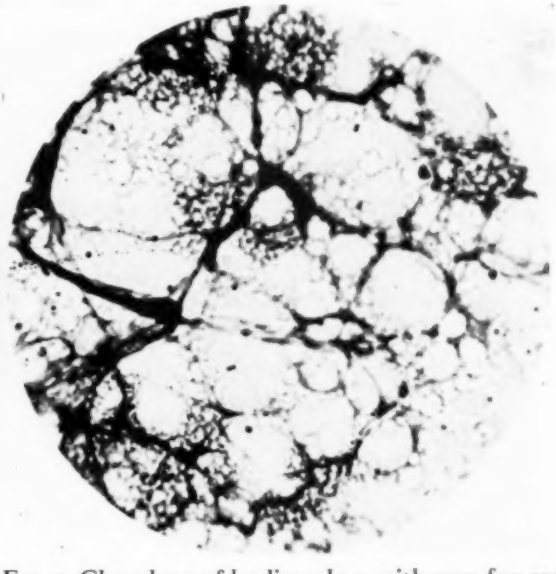

Fig. 7. Clean base of healing ulcer, with very few cocci present.

of the sloughs is the same as in the ulcer. They are surrounded by a ring of fibrotic tissue, and the base is also fibrotic. When these sloughs are treated by this method they heal very rapidly. However, in sloughs the base should be injected as well as the edges.

Of 25 cases (10 males and 15 females) treated by this method 7 patients (28 per cent) were between the ages of twenty

get a history of a considerable trauma to the leg, and these were the only two ulcers of less than one year's duration. In the other 23 cases the duration of the ulcers varied from one to thirty-four years (1 case). Two of the patients were not benefited by the saline injections alone. By applying the Unna paste boot and injecting every ten days we were able to effect a healing. We found that the number of

injections varied from 1 to 20. Only one recurrence was noticed, and was evidently due to a trauma.

The clinical course of the healing appears as follows: The edges soften, bleeding from the needle puncture is free, and pink and healthy granulations appear at the base and edges. A seam of epithelium grows from the periphery towards the center of the ulcerated area. The sections from the healing ulcer (Fig. 6) show the base clean, free from necrotic material, the infiltration diminished, rete pegs spreading over the edge. The most significant change takes place in the subpapillary capillaries. Normal vessels with a single row of endothelial lining appear instead of the thrombosed infiltrated capillaries. Smears from the ulcer reveal only few bacteria (Fig. 7).

DISCUSSION

The described method was successful in 88 per cent of chronic ulcers in indurated areas of the leg in a series of 25 cases. The technique is simple, the solution not toxic, the procedure therefore is not limited by contraindication. Of the other methods suggested for this condition, sympathectomy gives, according to Lariche, only temporary relief.

The circumcision of the ulcer has the disadvantage that it cannot be repeated, and leaves scars. Transplantation of skin is already a larger surgical procedure and often not feasible, because of the pathological conditions producing the ulcer.

SUMMARY

Chronic ulcers of the leg are caused by thrombosis and infiltration of the capillaries and stagnation in the smaller veins. A fibrotic ring surrounds the ulcer and cuts it off from the normal blood supply, thus preventing healing. Injection of normal saline solution through the edges is able to break down the fibrotic ring, and promote the formation of healthy capillaries and granulations. This method was also very successful in the treatment of sloughs, following the injection treatment of varicose veins by the sclerosing solutions, and in fact in the sloughs we treated by this method, the healing was extremely rapid.

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*Continued from p. 521.

TUMORS OF THE CAROTID BODY*

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TUMORS of the carotid body are among the neoplasms which are noteworthy for their extreme rarity, the literature dealing with these growths being indeed scant. Because of the importance of their immediate diagnosis by surgeon and pathologist, in order that proper surgical judgment may be displayed or correct therapy instituted, we feel that the report of any case of carotid body tumor is justified. Such tumors are so rare that the busiest surgeon or pathologist never becomes familiar with them through his own experience, but must learn from the collected experiences of others.

CASE REPORT

F. M. J., white, female sixty-six years of age, housewife, admitted to Hotel Dieu, complained of difficulty in swallowing, rapidly becoming worse so that she could only take liquid nourishment. This condition she attributed to pressure from a swollen gland in the neck. Although the gland had been present for one year, dysphagia was only of one month's duration. There was also associated a slight interference in speech and occasional annoying pains in the ear on the same side.

Present Illness: Began about one year ago, when a small, hard gland appeared on the left side of the neck. It caused no pain, or distress, but gradually enlarged. Not even the slightest discomfort was experienced until difficulty in swallowing presented about one month ago. Occasionally there was a slight sore throat. The appetite was poor. She lost 31 lb. in weight in one year. Past history brings nothing out that can have any bearing on the present condition.

The family history is negative for tuberculosis, cancer, cardiorenal disease and lues.

Physical Examination: On the left side of the neck there was a hard, non-painful tumor which elevated the skin about 3 cm. beyond the skin level. The mass was 12 cm. long and 3 cm. wide. It was definitely oval in outline, the overlying skin not being inflamed. The tumor, though firmly adherent to the surrounding structures was well circumscribed, the remaining cervical glands not being involved, nor was there any appreciable enlargement of lymph nodes elsewhere. The long diameter of the tumor was on a line with the deep vessels of the neck. General examination by the medical consultant showed an old lady in very poor physical condition. Blood pressure 258, systolic, 120 diastolic. The heart was enlarged, with permanent damage to the muscle and endocardium. The aortic second sound was accentuated and there was a soft systolic blow at the second right interspace near the sternum. Lungs and abdominal organs are negative.

The final report of the consultant was as follows: "Malignancy of cervical glands possibly secondary. Prognosis is hopeless. Even if blood pressure did not contraindicate operation, in my opinion, operation would be useless."

Clinical Laboratory Examinations: Blood: Total white cell count 7250. Differential count; neutrophiles 64 per cent, small lymphocytes 33 per cent, large lymphocytes 2 per cent, eosinophiles 1. Wassermann reaction of the blood negative.

Urinalysis: 1.5 per cent albumin. No casts present. Phenolsulphonphthalein excretion 25 per cent in two hours. X-ray of thorax shows no glandular enlargement and only slight enlargement of the heart to the left.

Preoperative Diagnosis and Indications for Operation: Malignant neoplasm of the left side of neck.

Indications:

1. The surgeon had a similar case four years ago, occurring in a female, sixty years of age. On thorough removal of the tumor, the patient entirely recovered and is living today. The pathologist at that time reported the growth as sarcoma, although the symptons, course and location were identical with that in the case here reported. No sections of the gland were preserved.

* From the J. T. Nix Clinic, New Orleans, La. and the Departments of Surgery and Pathology of the Medical Center, Louisiana State University, New Orleans, La. Submitted for publication December 3, 1930.

2. There is no evidence of extension or metastasis of tumor. It is apparently primary at this site.

FIG. 1. Paraganglioma caroticum. Low power, showing histologic analogy to normal carotid body. (Nix-D'Aunoy.)

3. In all directions beyond the tumor margin apparently healthy tissue is present.

4. The patient requires immediate relief as she can scarcely swallow.

Description of Operative Technique and Findings: A long incision was made extending from below the ear to the clavicle following the line of the anterior border of the sternocleidomastoid muscle. The muscle was adherent to the mass below and a large part of the muscle was excised. The tumor saddled the common carotid, beginning about 2.5 cm. below the bifurcation and extending about 0.75 cm. beyond, surrounding each branch. It was removed with little difficulty. Anticipating possible injury to the common carotid artery, a piece of heavy silk was thrown around the vessel, but it was not tied. The deep jugular vein was divided between ligatures. The external carotid artery was also divided between ligatures. A rubber tissue drain was left in the wound; the muscles were approximated with interrupted catgut. Interrupted silkworm gut with a continuous dermal suture was used for the skin. The operation was started with a local anesthetic but supplemented with ethylene and oxygen.

Gross Observation of Excised Tissue (from the records of Hotel Dieu, New Orleans): A mass of tissue about the size of a golf ball, irregular in outline and markedly lobulated, giving the impression that it is composed of a mass of glands matted together. On section, the tumor is firm in consistency and mottled, of ivory white and transluscent gray appearance. Every one of the constituent (tumors) the largest of which is the size of a pigeon's egg and the smallest the size of a small marble, shows the same general characteristics.

Microscopic Observation: The tumor has practically the same histological structure as that of a normal carotid body, a sinusoidal arrangement enmeshing epithelial-like cells varying in size but generally rather large. Most of these individual cells are polyhedral in shape with abundant granular cytoplasm

and rather large chromatic nuclei (Figs. 1–2). Here and there less differentiated cells resembling neuroblasts are seen. No ganglion cells or nerve fibers are demonstrable after application of either Van Gieson or the modified Bielschowski methods. Peripherally the cells show activity as evidenced by deeper staining reaction and some mitoses.

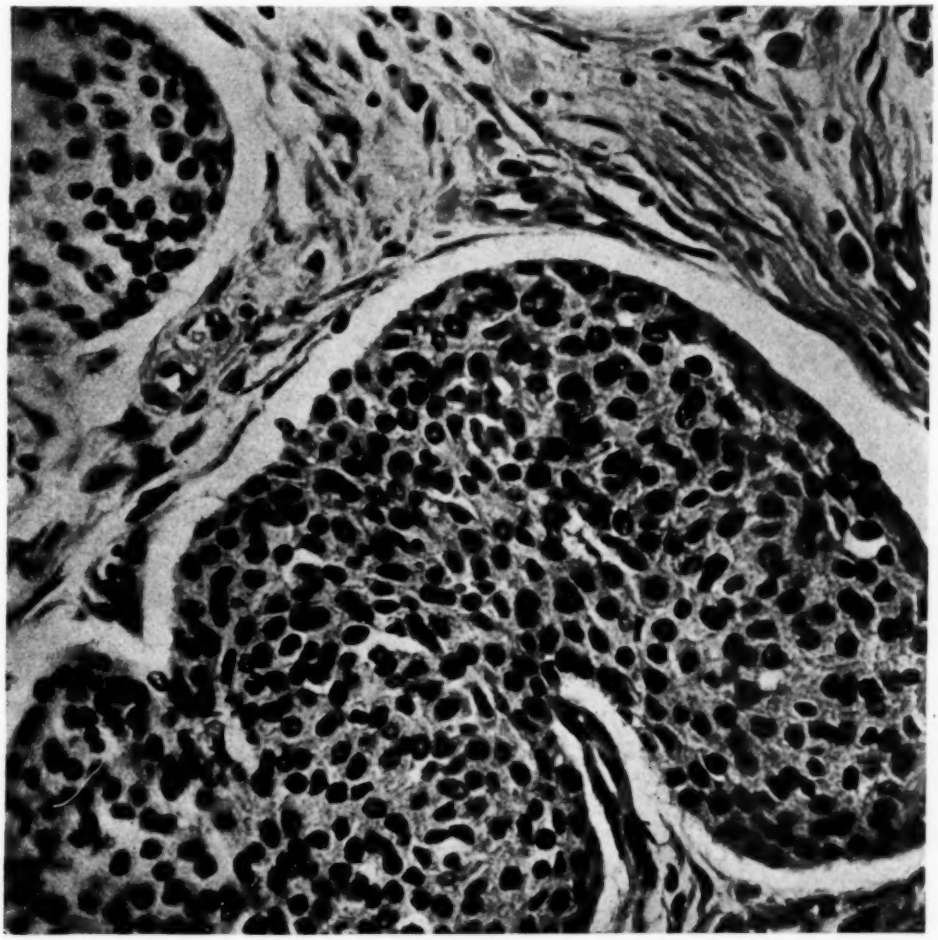

Fig. 2. Paraganglioma caroticum. High power, showing individual cell architecture

Final Microscopic Diagnosis: Paraganglioma caroticum.

Progress Notes: Recovery was uneventful. The drain was removed on the third postoperative day. Dermal sutures were removed on the eighth postoperative day and silkworm gut sutures on the twelfth postoperative day. The wound healed by first intention. The patient left the hospital on the twelfth postoperative day.

Follow-Up Notes: The patient was seen three months after operation. The wound had entirely healed, leaving a thin, firm line of incision. There was evidence of some loss of muscle, but the movements of the neck were not interfered with. There was no pain or discomfort, no difficulty in swallowing or talking. Blood pressure showed a decided drop, the maximum being 210 systolic, and 110 diastolic. Two months later the blood pressure was 190 systolic, and 110 diastolic. The patient felt well and was doing her own housework. There was no evidence of recurrence. The heart sounds were not as accentuated and harsh as before operation, and her general condition showed improvement.

We shall not attempt a review of the literature relevant to carotid gland tumors, due to the fact that this has been recently done in a most thorough manner by Bevan and McCarthy, in reporting a case of their own. These authors were able to collect 131 cases which they reviewed with much detail. They feel that the valuable lesson

to be learned from their study is that surgical removal of such tumors is to be undertaken only when it is not necessary to ligate the carotid arteries in order to complete the operation, since 30 per cent of such ligations have terminated fatally, and in a certain percentage of cases, ligations have been followed by permanent aphasia and hemiplegia. They stress the fact that more than 80 per cent of these tumors are certainly benign. The remaining percentage they feel probably includes lymphosarcomas and other malignant tumors of the neighboring tissues, which involved the carotid gland incidentally rather than originated in it. Since a procedure which offers a 30 per cent mortality risk is not to be considered in treatment of a benign tumor, and a malignant growth whose removal would necessitate the ligation of the carotids would give little prospect of a permanent cure, they conclude that removal of the tumor is justified only when such ligation is unnecessary. In their own case, *x*-ray therapy produced practically a cure, the tumor mass disappearing almost entirely with the patient free from symptoms thirteen months later. This leads them to the statement that "treatment with *x*-ray, with its very slight danger, is to be preferred to the operative treatment of these tumors which carries with it the enormous mortality of 30 per cent."

EMBRYOLOGY

The embryology of the carotid body has called forth much discussion which we shall not even attempt to recapitulate. The three theories which have been most prominently advocated are that it originates:

1. From the anlage of the sympathicochromaffin system (Zuckerkandl, Stilling, Kohn).

2. From the third or fourth branchial cleft (Stiede, Rabl, de Meuron).

3. From the perithelium of the carotid arteries (Kastschenko, Paltauf and Monckeberg).

The general concensus of opinion at the present time appears to favor the first theory. Sullivan and Fraser mention, "the neuro-epithelium from which the carotid body is derived," and base their discussion of carotid gland tumors on this premise. They state that "there can be little question that the carotid body represents one of the paraganglia of the sympathetic nervous system of which for instance the medulla of the adrenal gland is another and the best known,"

GROSS ANATOMY AND HISTOLOGY

The carotid bodies are usually two in number and are situated on either side, posterior to the common carotid artery at its point of bifurcation. They are of a brownish red color, oval in shape and average about 5 mm. in their long diameter. Their size and shape have been compared to a grain of rice (Jordon). Callison and Mackenty state that they are found in embryos 20 to 30 mm. in length and may be absent on one or both sides in embryo or in the adult. They reach their full development between the ages of twenty to thirty, and remain stationary for a period after which the interlobular blood vessels thicken, and sclerosis and atrophy of the organ results.

Careful description of the organ was given by Luschka in 1862. He and other writers recognized its intimate relation to blood vessels and nerves and due to this it has been named at various times the "globus caroticum," "ganglion inter-caroticum," and "paraganglion caroticum." Gray states that "the gland is invested by a fibrous capsule and consists largely of spherical or irregular masses of cells, the masses being more or less isolated from one another by septa which extend inward from the deep surface of the capsule." Jordon says that these masses of parenchyma are epitheloid cells. He describes the cells as "ovoid with finely granular cytoplasm and a spheroidal, somewhat vesicular nucleus," and states that many of them contain chromaffin granules. They have an alveolar arrange-

ment and lie in intimate relation with the capillary tufts with which they are richly supplied. The function of this gland, according to Jordon, is obviously similar to that of other organs of the chromaffin system and probably chiefly dependent upon the presence of adrenalin. Due to its genetic relationship and histologic similarity to a sympathetic ganglion, Kohn proposed the name "paraganglion caroticum."

According to Callison and Mackenty, the rich nerve supply of the organ is derived from both the central and sympathetic system, it receiving branches of the vagus, glossopharyngeal, superior laryngeal, and superior cervical sympathetic ganglion, which nerves form a plexus on its anterior surface. The capsule is rich in medullated and non-medullated fibers which penetrate it and the stroma from the plexus, interlacing intimately with the cell masses and capillaries. Here and there in the body of the organ a few scattered areas of ganglion cells are to be found.

PHYSIOLOGY

The physiology of the carotid body is not definitely known and the experimental work on the subject, the vast majority of which is not recent, is contradictory. Most of the work has been done on the premise that as a type of the chromaffin system its function deals with the regulation of blood pressure.

The organ is not constantly present, and its absence or removal apparently produces no noticeable symptoms. We incline to agree with Frugoni, who after a vast amount of experimental work doubted the existence of any important internal secretion originating from this body. In the case we report, however, there has been a very definite and sustained fall of both the systolic and diastolic blood pressure after the removal of the diseased organ.

PATHOLOGY

The pathology of the carotid body is limited for all practical purposes to the tumors, arising from it. These tumors vary in size from a few millimeters to 8 or 10 cm. in diameter, and vary in consistency from hard to soft, depending on the predominance of fibers or cells. Descriptions of the appearance of the reported tumors is strikingly similar, the variations which do occur being in color, density and arrangement, depending on which of the elements, capillaries, connective tissue, or cell rests, is predominant. The tumors are well encapsulated by a rather thick fibrous capsule and with dense fibrous trabeculae giving the external surface a rather nodular appearance with the trabecular ramifications dividing the interior into a series of lobules so that the surfaces presented after sectioning give an appearance which has been compared to fish-roe.

The most interesting discussion of the pathology of carotid body tumors is undoubtedly that of Sullivan and Fraser. They state that there are two types of these tumors representing the two most common differentiating neoplastic forms of the neuroepithelium from which the carotid body is derived. The more frequent histological type found as is generally admitted, is that which simulates closely the structure of the normal carotid body," a sinusoidal arrangement of the alveoli of fully differentiated paraganglion or chromaffin cells." The other group of these tumors include those which have been described by various authors as "sarcoma," "sarcoma-like," "psuedo-sarcoma," "endothelioma," "perithelioma," etc., the very multiplicity of these names suggesting the uncertainty of their nature. Sullivan and Fraser feel that:

> At least some of these various histological pictures represent different stages of cell maturation in another line of differentiation of the neural crest epithelium from which the sympathetic nervous system is derived, for example, neuroblasts, giving rise to neuroblastomas or capsule cells or perhaps Schwann sheath cells giving rise to neuro-blastoma-like tumors without true ganglion cells or axis-cylinders.

Sullivan and Fraser conclude that these types of tumors are neuroblastomas or at least varieties of neuromas and not tumors of fibroblastic or endothelial origin. The first type they consider as paragangliomas. They stress the fact that in the differentiation of the tissues derived from neuro-ectoderm there are several resting or rearrangement stages before the development of the ganglia and paraganglia of the sympathetic system is reached, these stages tending to give rise to neoplasms which, depending on their stage or origin, may be termed ganglioneuroma, paraganglioma, chromaffinoma or neuroblastoma. Since the first type of tumor is a faithful reproduction of the normal carotid body there could be no objection to the term "paraganglioma" unless the question were raised to doubt its nature as a true neoplasm and to consider it as rather a hyperplasia similar to that encountered in the thyroid in certain goiters, for instance. Sullivan and Fraser, however, dismiss this issue by saying that the latter condition may exist, but that in their case and in many of the cases recorded in the literature, the tumor showed central degeneration and peripheral growth which proved it to be neoplastic. Such can be said for the tumor herein reported.

Most authors agree that both types of the tumor may undergo malignant metamorphosis, the second group more frequently so than the first. However, we are inclined to agree with Royster, that carotid body tumors must be regarded as benign tumors, as they are usually of slow growth, perfectly encapsulated and do not give rise to metastases, or recurrences, when occurring being the result of incomplete resection at operation, with continuity of growth. The term "perithelioma" so frequently used in designating or describing these tumors, we consider inappropriate, as perivascular arrangement may conceivably appear in tumors of a most diversified nature. Further we even doubt the existence of perithelium in the sense of distinct cell elements or cell types.

DIAGNOSIS OF CAROTID BODY TUMOR

The diagnosis of carotid body tumor previous to operation is very difficult, as is evidenced by the fact that very few of the recorded cases were so diagnosed. The tumor is typically painless, of slow growth and present in the superior carotid triangle. The patient is usually prompted to consult a physician due to the noticeable tumor mass or pressure symptoms caused by it. Clinically it must be principally differentiated from the following conditions:

1. Primary lymphosarcoma
2. Metastatic carcinoma of the lymph glands
3. Aneurysm
4. Gumma
5. Tuberculous cervical adenitis
6. Aberrant thyroid.

The positive diagnosis of tumor of the carotid body cannot be made except by the pathologist after a study of miscroscopic sections. It may be assumed by the surgeon, but is impossible of differentiation from malignancy or some of the previously mentioned morbid processes.

TREATMENT OF CAROTID BODY TUMORS

The treatment of these tumors offers subject for much discussion. For many years, surgeons have recognized the fact that operative interference in these cases usually means ligation of the common carotid or one of its branches, which procedure carries with it in any case a high operative mortality. On these grounds numerous writers have warned against surgery in any but early cases in which the tumor can be removed without sacrifice of the great vessels. Other writers take the contrary position. Royster states that "prompt recognition and early removal even at the expense of resection of the large vessels appears to be the only rational plan." He further adds that, "no case successfully treated by medication or radiation has so far been recorded." Since this statement, however, Bevan and McCarthy have published their case successfully treated by *x*-ray. This report will undoubt-

edly stimulate other workers to similar attempts.

Sullivan and Fraser feel that "treatment can only be surgical." They subjected their 2 cases to surgery and state that they are vindicated by the fact that both tumors showed active growth and possible malignant tendencies, and that at the time of their report, several months postoperatively, the patients were free from symptoms.

We believe that with an established diagnosis, unless urgency of symptoms as was presented by our case indicates surgical intervention, that undoubtedly early resort to the *x*-ray should be had. In this respect, however, we desire to again call attention to the irrefutable fact that biopathologic examination alone can reveal the true nature of a growth encountered in this region. The condition should therefore be treated as would a malignant growth encountered elsewhere, and although radium and *x*-ray therapy have apparently established cures in some of the proved cases, the same methods have likewise proved efficacious in a greater or less degree with malignant growths in general. In general it may be said that surgery is undoubtedly the treatment of choice, supplemented with later *x*-ray or radium therapy.

SUMMARY

1. A case of paraganglioma of the carotid body, with symptoms of over a year's duration and with successful surgical removal is reported.

2. Embryology, anatomy, physiology and pathology of the carotid body are briefly discussed.

3. Since accurate diagnosis is impossible in these cases without biopathologic examination, surgery is the procedure of choice supplemented by *x*-ray or radium.

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LOCAL REDUCTION OF FRACTURES OF THE TIBIA AND FIBULA

REPORT OF FIFTY CASES*

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THE purpose of this paper is to put into practical form, a simple method for reduction of fractures of the tibia and fibula, but more especially fractures of the shaft of one or both.

In my opinion, the first thing of importance in the treatment of all fractures, and especially those of the lower leg, is the immediate reduction of the fracture. This should be done, if at all possible, within an hour or two after the injury. The following procedure is carried out in the order named.

1 Each patient is give a quarter (¼) grain of morphine.

2. A temporary splint is applied.

3. An *x*-ray picture, both anterior, posterior and lateral, is taken.

After the *x*-ray has been taken, the leg is first cleaned thoroughly and shaved, green soap, ether, and alcohol being used in the order named. The site of fracture is injected even though there is no displacement of fragments, because by so doing the patient is free from all pain during the process of putting on the cast. Ten to forty cubic centimeters of a 2 per cent solution of novocaine is injected into the hematoma, or hematomas, at the site of each fracture shown on the *x*-ray plate. Great care should be taken in injecting the novocaine in the hematoma that blood is returned into the syringe before the injection is made. It should be understood that the hematoma of every fracture must be injected in order that the patient be free from all pain. After the injection is complete at least fifteen to twenty minutes should elapse before further procedure and in cases that are not seen for five to ten hours after the accident you should wait at least thirty minutes or more, the reason being that the hematoma is more organized, the result being that the novocaine is not as well distributed. A 4 in. piece of muslin bandage is then used to apply a clove hitch about the ankle of the patient, the ends of which are tied about the waist of an assistant, whose weight serves to help produce a steady traction on the leg while the rest of the procedure is carried out. As this traction is applied the muscles will be found to be perfectly relaxed and the patient will be completely free from pain. If swelling is present which in some cases occurs at once, but in most cases does not occur for an hour or more, it is necessary to massage the leg thoroughly and carefully, the result being that by ten or fifteen minutes of careful massage that all or nearly all of the swelling can be eliminated. If at the time this traction is applied, the patient complains of pain, it is because the novocaine has not entered into the hematoma at the site of the fracture, or fractures. As this pull is applied by the assistant it takes a relatively small amount of manipulation to put the bones into perfect anatomical position. This can be determined by the use of a fluoroscope under which the entire reduction is done. When the fragments are found to be in satisfactory position one is then ready to apply plaster bandages to the leg. The plaster is applied directly to the skin which is contrary to most teachings. This is done by first applying a plaster bandage which is made by several thicknesses of plaster of Paris bandage being placed on a board. This bandage is applied from a distance of about 6 in. above the knee, posterially, down to the bottom of the foot to a distance of about 1 in.

* Submitted for publication January 5, 1931.

above the toes. Great care is taken to see that it is applied very smoothly and that there are no wrinkles in the bandage; also that it is cut at an angle under the ankle so that there is an overlapping at the ankle rather than a wrinkle. Plaster is then applied circularly over the entire leg from a distance of about 6 in. above the knee to the toes, care being taken to apply the plaster evenly and snugly but not too tightly. By "not too tightly" we mean to merely place the plaster about the leg but not to roll it or put any pull on the plaster bandage. The plaster is applied with the clove hitch and traction still intact, the leg being examined from time to time under the fluoroscope to see that proper position is maintained at all times. The walking iron as designed by Dr. Forrester is incorporated into the cast, care being taken to see that it is parallel to the axis of the tibia. (For description of the walking iron, see Fig. 1.) As soon as the plaster has fully hardened, an *x*-ray picture is taken to see that proper anatomical position is present. If the bones are in good apposition the clove hitch is removed dorsally, by cutting the edge of the cast. If the clove hitch is left under the cast a pressure necrosis would result. The patient is then put to bed and the foot elevated on two to three pillows, with instruction to both the patient and the nurse to see that the toes are moved at regular and frequent intervals, the purpose of this being to eliminate any swelling that may result. By this procedure, I have not as yet had to remove but one cast and in this case it was due to a roughening of the cast which could have been eliminated had I applied the cast smoothly. The patient is allowed to put his full weight on the walking iron in three to four days with the aid of a crutch or cane and in some cases without any support, the full weight being borne on the broken leg, the weight falling on that part of the leg above the fracture. Walking on the leg does not cause the patient any great amount of discomfort and does not endanger the position of the fragments. This is true in all cases excepting those cases where the upper end of the tibia and fibia is broken into the joint capsule. This

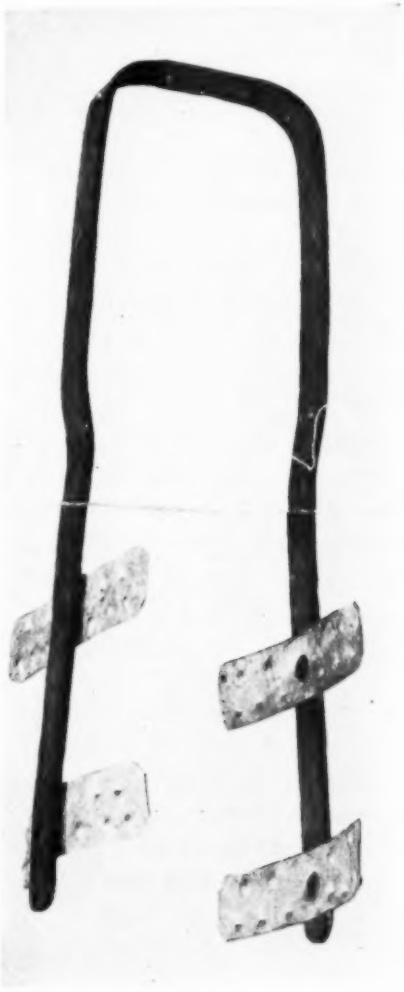

Fig. 1.

method which I have described applies only to fractures which are sufficiently transverse so as to allow the edges to become hooked.

Treatment of Fractures, the Fragments of Which Cannot Be Held in Position by the Cast Alone

In these cases where there is a long oblique fracture of the tibia, it is necessary to hold the fragments in place by a steady continuous pull on the leg. This is best done by the use of a Steimann nail through the os calcis on which sufficient weight is applied to keep the fragments in position

as shown by *x*-ray examination. After this traction has been applied and maintained for approximately fourteen to twenty-one days, a cast is applied and the leg treated as in the case of an ordinary transverse fracture of the shaft.

TREATMENT OF COMPOUND FRACTURES

Compound fractures are treated in the same manner, with the following exceptions:

The injection of novocaine is made from the side opposite the wound and around the entire site of the fracture, by the use of a long fine needle. The wound is treated as follows:

The wound is cleaned thoroughly with green soap and ether and a debridement is done as completely as possible, after which the wound is cleaned with a solution of iodoform in ether in the proportion of 2 dr. iodoform to 1 oz. of ether. The skin is closed with silkworm gut and the fracture treated as if it were a simple fracture. No window is left in the cast although the patient is watched very carefully for the development of gas-bacillus infection. It is routine procedure to give 100 c.c. of Lederle's gas-bacillus antitoxin in all cases where the wound has been exposed to (street dirt). In only 1 case has it been necessary to remove the cast and treat the infection of the skin, which fortunately did not result in osteomyelitis.

ADVANTAGES OF THIS METHOD OF TREATMENT

1. Elimination of the dangers of anesthesia in such cases as pulmonary tuberculosis, hypertension, cardiorenal and cardiovascular conditions, etc.
2. More complete relaxation of the muscles and better resulting anatomical position with a longer period of manipulation possible inasmuch as the anesthesia lasts from two to two and one-half hours.
3. Shorter period of hospitalization.
4. No atrophy of the muscles of the leg because of the patient's being allowed to walk much sooner and because the normal circulation to the parts is maintained there is less fibrosis and no resulting osteoporosis.
5. Lessened chance of non-union due to decreased circulation.
6. Shortened temporary disability and lessened permanent disability.

In writing this paper, I wish to express my appreciation to Dr. C. R. G. Forrester for the help that I have had from him in the treatment of fractures by this method.

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*Continued from p. 491.

PRIMARY SUTURE OF COMPOUND FRACTURES

REVIEW OF 70 CASES*

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THE first consideration of any treatment of fractures must be the saving of the patient's life, next the preservation of the extremities, and lastly to restore, in the shortest time possible, the function of the injured part. Compound fractures greatly increase the difficulties of accomplishing any of these aims.

Theoretically, the ideal treatment of compound fractures would be to convert them into simple fractures. Last year while working in the wards of Mr. Donald Duff, surgeon in the Royal Infirmary, Glasgow, Scotland, I had an opportunity to observe the results of primary suture of compound fractures. With his permission, I am publishing the results which his group obtained in a series of 80 consecutive compound fractures occurring in 70 individuals.

The compound fractures were usually the result of greater trauma than simple fractures. Many were associated with other injuries, which made them more serious. In this series, 12 were compound skull fractures, associated with brain injury. Two of these patients died within twelve hours. Of the remaining 10, 1 died of septic meningitis following excision and packing of the wound. The other 9 were treated by debridemont, removing the dirty bone fragments and suturing the wounds. One of this number became infected, developed a hernia cerebri, but recovered. There were 12 patients who had more than one compound fracture. Five were complicated by simple fractures elsewhere.

The compound fractures were usually the result of a direct force and were much more common over the superficial bones.

Over 75 per cent of the compound fractures were the result of direct violence. However, many compound fractures of the upper extremity were caused by indirect violence.

TABLE 1

Location of Fractures	Number	Per Cent	Direct	Indirect
Tibia and fibula.	27	33.75	22	5
Skull	12	15.0	12	
Tibia	10	12.5	4	6
Foot	6	7.5	6	
Humerus	4	6.25	1	3
Femur	4	5.0	4	
Hand	4	5.0	4	
Radius and ulna	3	3.75	..	3
Ribs	2	2.5	2	
Astragalus*	2			
Fibula, ulna, pelvis	1	1.25		

* Fracture dislocation.

We must examine this series as to the deaths and the causes of death. There were 7 deaths. Two patients died from shock and hemorrhage; 2 died within twelve hours as a result of brain injury; 1 died of meningitis, following a compound fracture through the frontal sinus. The sixth person died from bronchopneumonia combined with brain injuries, four days after admission. One patient having fracture of the pelvis died of internal hemorrhage. The first patient died upon the table while the surgeon was cleaning the wound. The second person died thirty minutes after an anterior racket amputation of thigh was done. This patient's life might have been saved if a blood transfusion had been given immediately before operation. There were no deaths attributable to sepsis following suturing the wound. One patient died of internal hemorrhage; no operation was performed.

There were 8 amputations, 4 primary and performed because of the extensiveness

* Submitted for publication January 5, 1931.

of the fracture and the great injury of the soft parts. Two amputations were performed because the blood supply of the extremity was insufficient and the part became gangrenous. Two secondary amputations were necessary to control spreading virulent infections in the wounds.

TABLE II
CAUSE OF DEATH

Type of Fracture	Cause	Deaths
Vault of skull through the frontal sinus...	Meningitis	1
Lacerations of femoral vessels, fracture of shaft of femur	Shock, hemorrhage	2
Base of skull.....	Brain injury	2
Vault of skull.....	Brain injury Bronchopneumonia	1
Fracture of pelvis....	Rupture of bladder Internal hemorrhage	1

TABLE III
AMPUTATIONS

Cause of Amputation	Primary	Secondary	Deaths
Bone shattered, great injury of soft parts.	4		
Insufficient blood supply.....	2	2	1
Infection.....	..	2	

The average length of time spent in the hospital was 44.5 days for all this series of compound fractures. Only 3 persons were treated expectantly but these patients averaged fifty-nine days. The length of stay of patients having compound fractures which became infected was 62.5 days. While the number of persons treated expect antly was small, their average stay was 14.5 days longer than that of the whole group. Taking 100 compound fractures in one year, the hospital would save 1450 hospital days, an enormous saving from an economic standpoint. Furthermore, the average was somewhat increased by the fact that there were 10 secondary operations, performed with an average time of 59.75 days. Two were amputations for infection; 5 were for the removal of sequestra; 1 was a skin graft to repair the damage resulting from a sluff of skin; 2 were for malunion.

TABLE IV
AVERAGE LENGTH OF TIME IN HOSPITAL

Type of Treatment	Number of Fractures	Days in Hospital
Debridemont plus primary suture.....	77	44.5
Debridemont.....	3	59
Infections.....	10	62.5
Secondary operations.....	10	59.5

Nonunion, delayed union, and malunion are supposedly much more common after compound fractures than simple fractures. In this series nonunion did not occur. Delayed union appeared in 2 instances, and malunion twice. We have been taught that sepsis tends to delay the healing of the fracture and results in these conditions. It is interesting to note that the delayed union occurred in clean fractures. Nonunion is almost always caused by too zealous removal of the splintered portions of bone, leaving a gap which cannot be bridged by the bone. It was prevented in this series by the preservation of all the bone splinters possible and by the suturing of the soft parts over them so as to give them the best chance of life. Delayed union is more apt to occur in transverse fractures with very little comminution.

These patients were seen first in the gate house of the Royal Infirmary. The external dirt and filth were cleaned from around the wound and the skin painted with methylated spirits, followed by iodine. A splint was placed upon the extremity and the patient was sent to the wards. No attempt was made to reduce the fracture. In the wards the patient was treated for shock with electric cage, hot drinks, morphia. Antitetanic serum was administered at this point.

That night the patient was taken to the operating room. The wound was thor-

oughly cleansed with ethereal soap, methylated spirits, and iodine. Any dirty fragments of bone were clipped off by a rongeur or chipped off by a chisel. A debridement of the soft parts was done, all bleeding stopped. The fracture was reduced, the skin loosely stitched with silkworm gut. A splint was applied, and the patient sent back to the wards.

If no infection developed, the wound was treated by dry dressings and the fracture as a simple fracture. If the patient began to complain of a good deal of pain in the wound, associated with increased temperature, the wound was examined. If the edges were reddened and edematous the stitches were removed, free drainage was established, and the treatment proceeded as that of an infected wound.

There were 10 infections in the 80 compound fractures. Three were slight, not requiring the removal of the stitches. Three infections occurred in wounds in which foreign bodies were introduced: two in which the bones were wired with silver wire, and the other in a wound in which a Lane's plate was used. Two occurred in very bad crushing injuries of the foot, in which it was impossible to do a thorough debridement without amputating the foot. Both men had useful feet in spite of the infection. One occurred in a depressed fracture of the skull in which a portion of the left frontal lobe was left upon the fender of an automobile. It was impossible to remove all the dirty and bruised tissue from this wound. This child developed a hernia cerebri, but after a long period in the hospital was discharged apparently well, but with a large defect in the frontal bone. In two of the infections, the process was so severe that amputation was required, the patients losing their legs but not their lives.

Statistics are not very reliable. Two people reading them get entirely different impressions. From the study of these patients and the observation of them in the hospital, I have tried to form a fair opinion of this method of treatment.

In the first place, the results of this series are inferior to those obtainable by a good surgeon in private practice for the following reasons: (1) The streets of Glasgow are always covered with a lot of dirt, horse manure, and filth not found in American cities. (2) It was the custom to operate upon these patients at the end of the receiving day; thus the operations were performed from one to twenty-three hours after the accident. (3) The results seemed to depend upon the thoroughness of the debridement. (4) The patients of this hospital were often very dirty and wore quantities of filthy underwear. (5) Due to poor food, housing, and climatic conditions, the resistance of the individuals to infection seemed lower than that of patients seen in private practice. And, (6) due to the large number of patients, many of these individuals were dressed and taken care of by the nurses with some supervision by the surgeons.

This is not a method to be adopted by every practitioner or surgeon. It requires a skill and judgment not possessed by every operator, and a careful technique not possible to carry out without a thoroughly trained operating room staff. Used in selected fractures I believe it is the best method of treating compound fracture.

It is the method of choice in compound fractures due to indirect violence, and in those due to direct force in which there is not too much bruising and laceration of the soft parts, including the skin. It should be done in all compound fractures of the skull. It should be done in all compound fractures in which the main blood and nerve supplies are intact. It is the method of choice in these fractures if seen within six hours of the injury. It is not the method of choice in fractures seen after this time, in very extensive lacerations and contusions in which it is impossible to remove all the injured tissue without gravely injuring the function of the limb, in cases in which debridement is not complete, where it is impossible to check the oozing, in places in which a

thorough debridement would sacrifice main blood vessels or nerves, or in the face of obvious pyogenic infection within the wound or in other parts of the body. Debridement alone should be used in groups not suitable for primary suture except in obviously infected wounds.

The technique I believe to be the best for the first group is the following: When first examined, no attempt is made to reduce the fracture. The area around the wound is shaved, cleaned with alcohol and benzine, and painted with 3.5 per cent iodine, a sterile dressing, a splint applied, antitetanic serum given, and the patient is sent into the hospital where he is treated for shock in an electric cage, with heat, saline, fluids, morphia for pain, and a blood transfusion if necessary. After he has recovered from shock, he is taken to the operating room. The patient is anesthetized, the wound and surrounding parts being cleansed with ether and green soap, alcohol, and 7 per cent iodine. The iodine is allowed to dry. Then the excess is removed with alcohol. The patient is draped and the operation proceeded with, using rigorous asepsis, all tissues, sutures, sponges, being handled by instruments instead of the fingers. Keep the fingers out of the wound. A longitudinal elliptical incision is made around the fracture wound, conserving as much of the skin as possible. The incision must be long enough to permit easy exposure of underlying structures. The knife is now discarded and fresh towels are clipped to the wound edge. The edges of the wound are opened widely and a generous excision of the subcutaneous tissues is carried out. The fat is of no value in the closure and any damaged fat tends to promote infection. When the deep fascia is reached, one is more economical, making the incision parallel with its fibers and removing only a narrow ellipse around the wound. Below the fascia one must exercise great care. All the great vessels and nerves lie in this region. They are inspected, and if damaged suitable steps are taken to repair them. Damaged muscle tissue is removed, but as much normal tissue left as possible. It is necessary to remove all muscle tissue which does not bleed, or only very slightly, and does not contract when pinched. The edges of the bone are chipped off with a chisel. All obviously dirty fragments are removed, unless they are very large, thereby leaving a serious bony defect, in which case they are treated as the dirty ends of the bone. All other fragments are left in the wound, even if detached, for they act as chip grafts in the wound. It is essential not to leave the wound open if this is practiced, because in an open wound they all die and have to be extruded. The wound must not be probed with instruments or the finger. Also, the operator must be careful not to leave any portion of the sinus tract which may have been hidden by the shifting of the sinus's position, either by contraction or relaxation of the surrounding muscles. This, I believe, can be accomplished by doing as thorough a debridement as possible, then pulling the bony fragments in as good a position as possible. This will probably reveal any hidden portions. At any rate, the maneuver will obliterate much dead space and minimize chances of infection. It is not wise to try to manipulate the fragments into place by the use of instruments introduced into the wound because of the danger of causing new traumatism of soft tissue and opening new avenues of infections. Absolute hemostasis is necessary. The skin is then closed loosely with interrupted sutures of silkworm gut.

All other compound fractures except the obviously infected ones are treated by a thorough debridement, but no attempt is made to close the wound by primary suture. If infection develops, it is treated by the Carrel-Dakin method.

Obviously infected compound fractures must suffer as little meddling as possible. Debridement is contraindicated. The fracture must be reduced to get rid of the large cavities which lie between the displaced fragments and which are apt to give rise

to abscess formation. After reduction, the blood vessels which have been compressed and displaced by the fragments are again free and the blood supply to the extremities is improved. Then the fragments must be completely immobilized and kept so. There is no greater mistake the surgeon can make than that of removing the splints when infection occurs and only treating the wound as such. Very few treat an abscess by sticking a finger into the cavity and moving it around at a great rate. Yet that is what a surgeon does when he fails to immobilize the infected fracture, and he need not be surprised if the patient has a chill after a dressing or if the patient succumbs from a general septicemia. Provision must be made for adequate drainage. The incisions are guided by anatomical reasons and are not always placed in the most dependent part. All pus accumulates in fascial planes and rarely perforates the strong fascia. Particular care must be exercised in avoiding large vessels for if drainage is too near the blood vessel, the latter may be eroded and the patient may die of secondary hemorrhage. If later, it becomes necessary to make additional incisions for drainage, the fracture must be kept reduced and immobilized throughout the operation; otherwise it may lead to a displacement of the fragments and a change in the course of blood vessels and nerves may result, and the latter be injured by the incision. Irrigations of warm Dakin's solution are helpful.

CONCLUSIONS

1. Primary suture is not safe for the general practitioner or occasional surgeon.
2. Debridement should be practiced within six hours of the injury.
3. The results will depend upon the thoroughness of the debridement.
4. Debridement plus primary suture is the operation of choice in compound fractures due to (a) indirect force, (b) direct force without a great loss of tissue, (c) skull fractures, and (d) in comminuted fractures without too great a loss of soft tissue.
5. Debridement and Dakin's treatment are indicated in compound fractures (a) six to twenty-four hours old, (b) in conditions in which it is impossible to remove all damaged tissue without gravely injuring the function of the limb, (c) in which debridement is not complete, and (d) in which there is a good deal of oozing.
6. Thorough drainage and Dakin's irrigation are indicated in obviously infected limbs.
7. Non-absorbable sutures, plates, or bands tend to promote infection.

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ACUTE LYMPHATIC LEUCEMIA*

REPORT OF CASE

FRANCIS S. MAINZER, M.D.

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ACUTE lymphatic leucemia was first described by Hughes Bennett in 1845 and a year later (1846) by Virchow. Ehrlich recognized it in 1876 and described it under two forms: (a) the splenic myelogenous, (b) lymphatic. The first was characterized by hyperplasia of the spleen and marrow elements while the second by hyperplasia of the lymphatic glands. The acute lymphatic type is a progressive fatal disease of unknown etiology characterized by a sudden onset, fever prostration and a tendency to necrotic or gangrenous processes in the mucous membranes of the mouth and throat with no marked enlargement of the spleen, liver or lymph glands.

Etiology: Recent investigations show a tendency toward the theory that infection plays a part in the production of leucemia, as certain microorganisms have been reported causative, but nothing can as yet be said as definite with relation to the specific etiology of the disease.

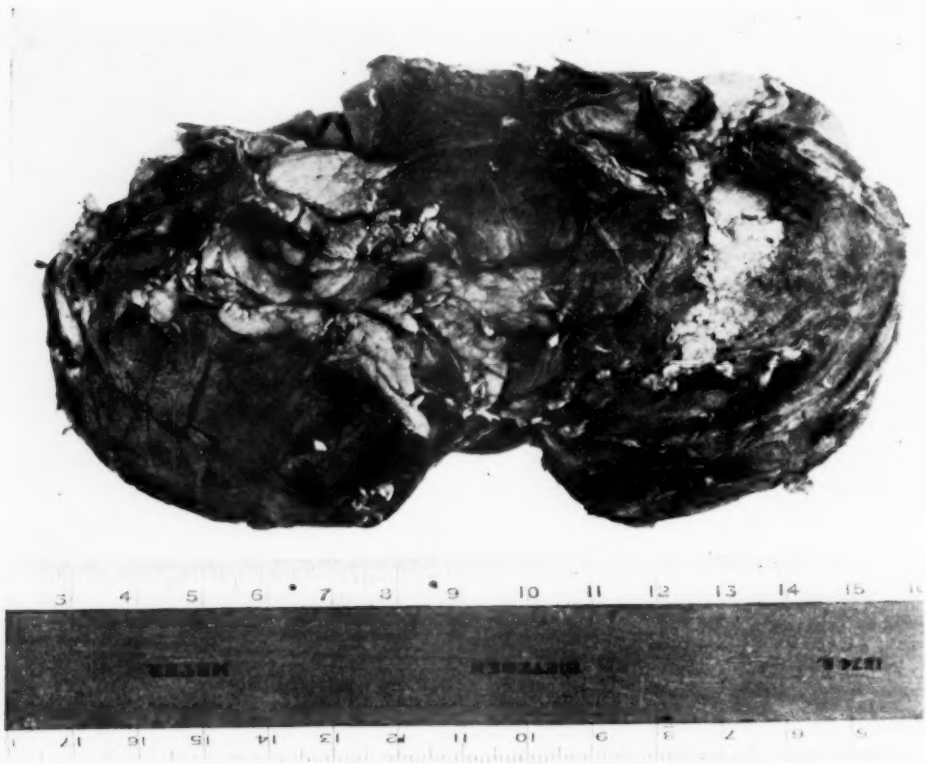

FIG. 1. Kidney in capsule, demonstrating enlargement.

Symptoms: The onset may be acute or gradual, with or without a chill, fever, weakness, profound prostration, sore mouth and in some cases nausea and vomiting. Anemia manifests itself early by pallor, muscular weakness, headache, vertigo and swelling of feet.

Physical signs: Loss of weight is usually marked. The glands of the axilla, groin and neck are as a rule affected.

*From the Department of Surgery Clinic of S. J. Waterworth, M.D., Clearfield, Pa. Submitted for publication January 9, 1931.

Splenic enlargement is not marked early. The skin may show three types of lesions; (a) ecchymosis, (b) subcutaneous abscess, (c) leucemic nodules. The urine contains albumin, hyaline and granular casts and at times blood.

Blood study: Anemia is as a rule marked. The red cells vary from 700,000 to 5,000,000, while the hemoglobin ranges from 20 to 60 per cent. The distinctive pathologic increase of lymphocytes is present in a few days after the onset of attack and becomes progressively worse until the death of the patient. The white blood count varies from 10,000 to 265,000 per cubic millimeter of blood. The lymphocytes dominate and constitute from 70 to 98 per cent of the white cells. Some authors state that the polymorphonuclear count is high at the beginning, being replaced in a few days by the lymphocytes. The blood platelets are diminished.

Prognosis: In the acute type recovery so far is unknown; it never occurs. The patient usually expires in less than three months after the onset of the disease.

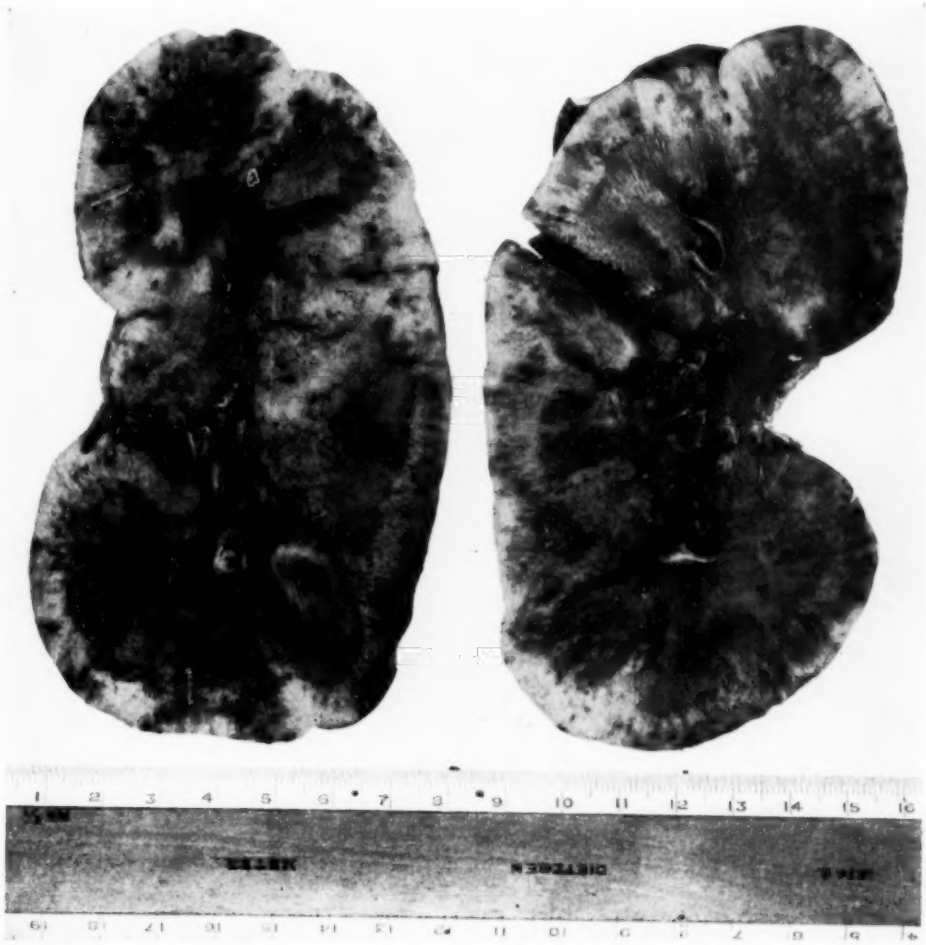

Fig. 2. Sectioned kidney showing diffuse, pale, waxy character of lymphomatous infiltration and numerous petechiae.

Diagnosis is sometimes made with difficulty but is suggested with the acute or sudden febrile onset and the blood picture. Repeated blood examinations, enlargement of the lymph glands make the diagnosis clear.

Treatment is symptomatic. In acute cases, especially of the lymphoid type, roentgen-ray treatment is usually unavailing and sometimes has seemed to hasten the fatal termination. Animal experiment shows that the roentgen-rays have a selective action upon the leucoblastic

tissue and that under their use the lymph glands, leucoblastic marrow and spleen undergo rapid atrophy.

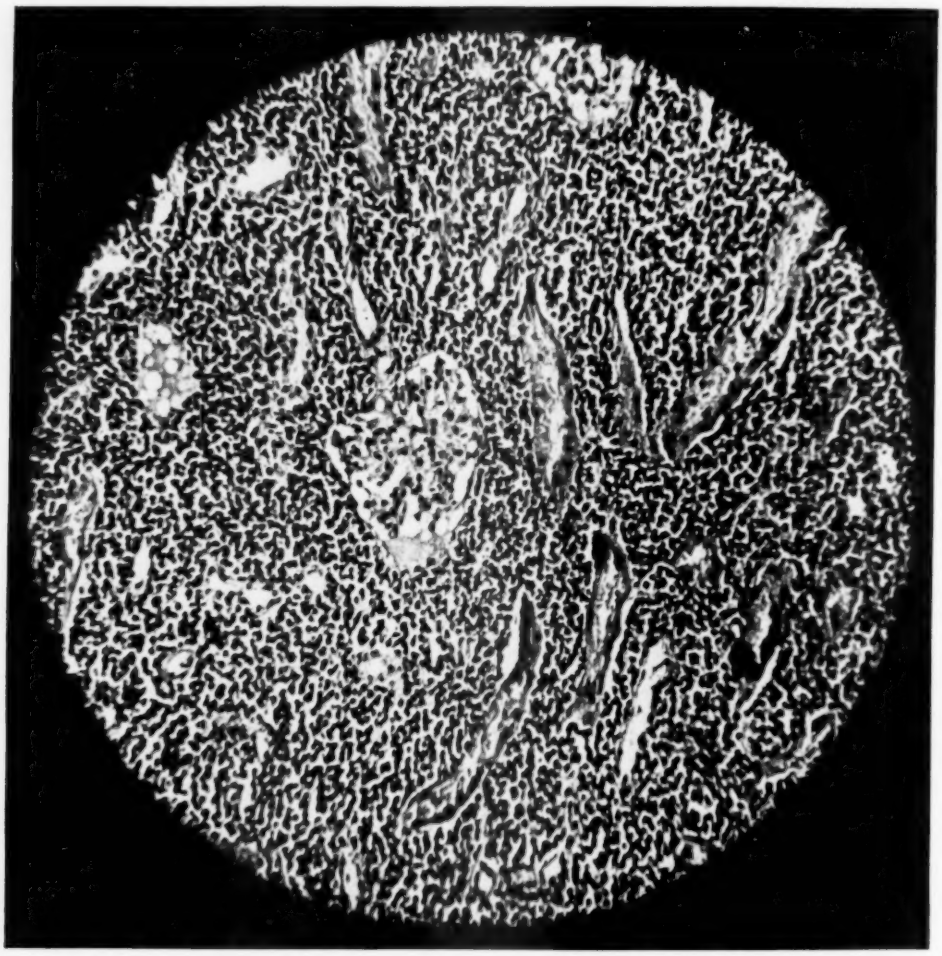

Fig. 3. Kidney, magnification × 250. Diffuse deposition of lymphoid cells well shown.

CASE REPORT

T. M., was admitted to the Clearfield Hospital June 20, 1930. The parents stated that the child was fretful and peevish, appetite was poor, slept poorly. These symptoms had been present for three months, becoming gradually worse. The child was able to be around but did not play as other children of her age.

Physical Examination: fairly well nourished female about four years of age, rather anemic. Head, scalp normal; eyes, pupils equal, react to light and accommodation; nose, septum deflected to the right; ears, no discharge, hearing good; mouth, teeth good, tongue coated, throat injected, tonsils enlarged and infected; neck, cervical glands palpable; chest, normal vesicular breath sounds are present over the entire lung areas, no râles; heart, both sounds present over the apex and aortic region, rate and rhythm good, no murmur; abdomen, walls soft, liver extends down to the umbilicus on the right side, spleen palpable; extremities, normal. Temperature 100°F., pulse 100, respirations 23. Blood study, hemoglobin 75 per cent, red blood cells 3,480,000, white blood cells 14,000, polymorphonuclears 72, small lymphocytes 27, large lymphocytes, platelets 120,000. Urine, specific gravity 1.020, reaction alkaline, albumin trace, microscopic, squamous cells, few epithelial cells.

The second day following her admission the parents took the child from the hospital, hence no definite diagnosis was made as study was not complete. Her second admission to the hospital was July 20, 1930 (a month later) at which time the chief complaint was fever, enlarged abdomen. The parents stated that since the child had left the hospital they noted the abdomen becoming larger and general condition worse.

Examination at this time revealed marked anemia with pallor, palpable glands of neck; heart rapid with roughening of first sound; greater than normal. There is an unusually small amount of gas. The diaphragmatic movements are normal and equal on both sides.

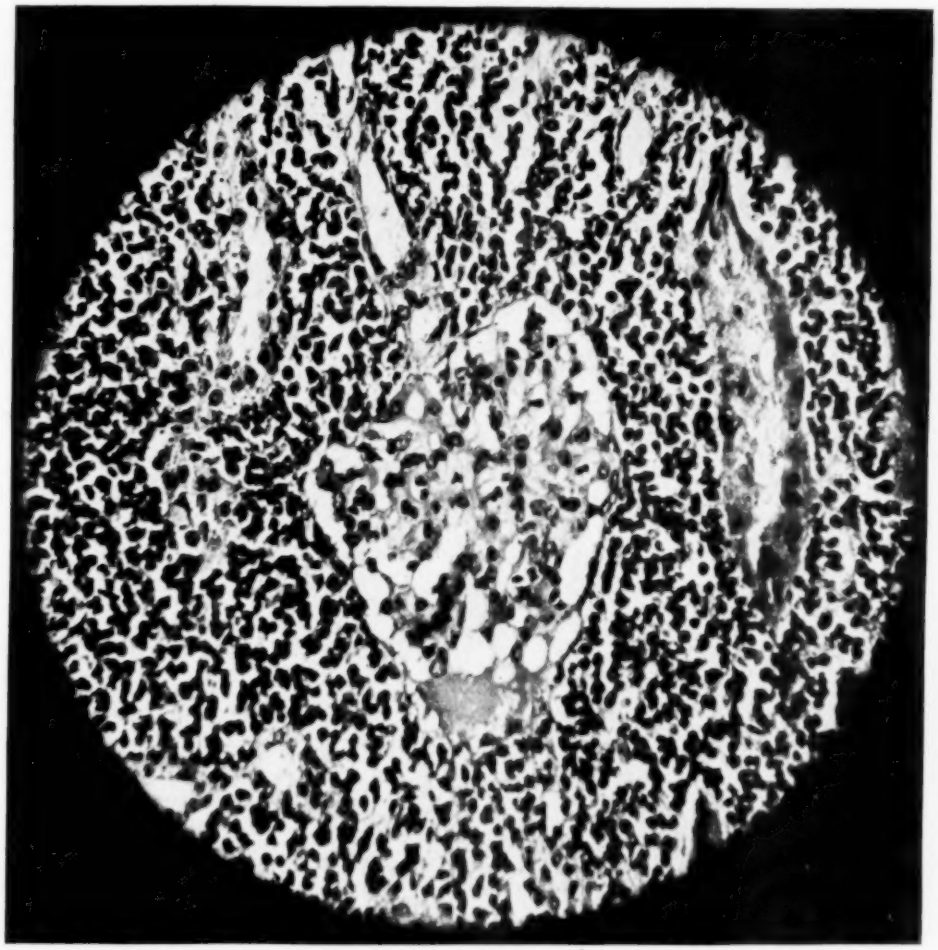

Fig. 4. Kidney, magnification × 450. Lymphoid cells may be identified as well as acute glomerular lesion, and dengenerative changes in tubular epithelium.

lungs, scattering râles over the bases of both lungs with dullness over these areas, abdomen, markedly distended, liver enlarged, large mass about the size of a grapefruit palpable in the left side. Temperature was 101°F., pulse 130, respirations 24. The blood examination showed the hemoglobin to be 20 per cent, red blood cells 1,010,000, white blood cells 88,050, polymorphonuclears 4, small lymphocytes 90, large lymphocytes 5, transitionals 1. Urea-nitrogen 9.34 mg. per 100 c.c. of blood, creatinine 1.5 mg., sugar 96 mg. Feces salmon color, soft stool, negative for tuberculosis, no blood. Urine, specific gravity 1.012, reaction acid, negative for sugar, albumin negative.

Roentgen-ray of abdomen was taken with the following report: The density of the abdomen above the iliac crest seems to be much

On account of the mass in the left abdomen it was decided to do a cystoscopic examination for pyelograph of left kidney which report was as follows: Catheter is coiled in a rather long slim pelvis for a child. Only the superior calyx fills. A small minor calyx is blunt as if broken off. The solution runs back into the bladder without filling the pelvis. The ureter enters the elongated pelvis at a right angle. The pelvis is undoubtedly deformed by a tumor, the outline of which is obscured by the gas-filled stomach and colon. The child was given several blood transfusions by the Unger method which increased the hemoglobin while the red cells remained the same. The white cells decreased following each transfusion. Consultation was held after which it was decided to do an exploratory operation

as the mass on the left side was suspicious of being either sarcoma or hypernephroma. On August 1, 1930, exploration was done by Dr. S. J. Waterworth with the following report: Usual incision was made for exposure of the left kidney; posterior parietal peritoneum adherent to the whole anterior surface of the kidney which stripped off readily. Dissection of the ureter and pedicle very readily accomplished. The kidney had an amyloid appearance. At no place had there been a break in the capsule. The perirenal fat appeared normal. The ureter was dissected down to the brim where it was ligated, pedicle doubly clamped and doubly ligated; the wound was closed with chromic catgut; skin closed with strips of sterile adhesive plaster. Following the operation the child had a moderate postoperative reaction but in five days the temperature was normal, pulse ranged from 80 to 90, the respirations from 20 to 23. The hemoglobin rose to 50 per cent, red blood cells to 2,300,000, white blood cells dropped to 10,500, polymorphonuclear 50 per cent, small lymphocytes 43, large lymphocytes 3, transitionals 2, eosinophils 2.

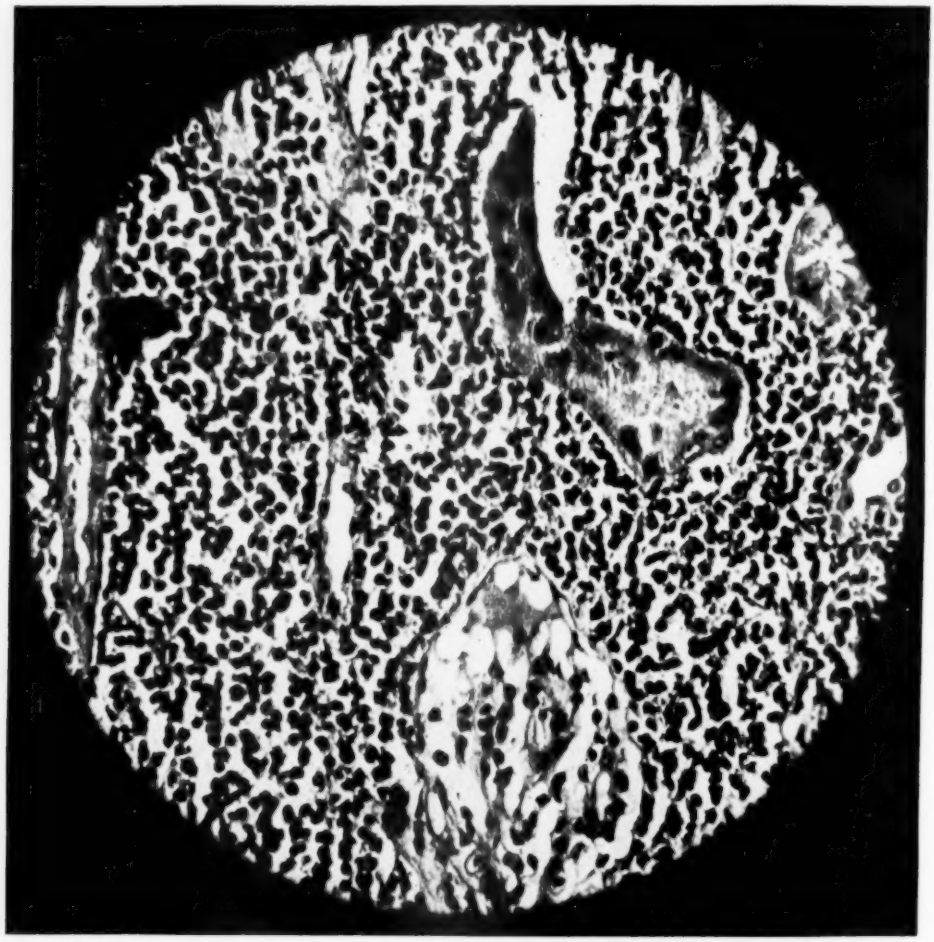

FIG. 5. Kidney, magnification × 450.

Five days after the operation the wound was practically healed but the temperature started upward, reaching 101.2°F. two days later. The white cell count was again increasing, hence it was decided to give mercurochrome intravenously although the blood culture was normal. The patient was given three injections of mercurochrome intravenously over a course of twelve days with no improvement of temperature, while the white cell count was markedly increasing. Two weeks following operation a mass was palapable about the size of a small grapefruit in the right side which was diagnosed as an enlarged kidney. The kidney function after operation was good, urine showed a cloud of albumin with hyaline and granular casts.

The pathological report of the specimen removed at operation was as follows: "Large

firm kidney 15 × 7 × 6 cm. Capsule strips easily bearing a smooth pale grayish white surface on which a few petechiae are scattered.

The patient was given three more transfusions by the Unger method. The white cell count kept increasing as did the small lympho-

NAME – T.M. HOSPITAL – NO. 38796
LABORATORY–NO. 27542

DATE	HB	R.B.C.	W.B.C.	POLYS	LYMPH	LARGE	TRANS	EOS	SPECIAL
7-21-30	20	1,010,000	88,050	4	90	5	1		
7-23-30	35	1,250,000	56,800	4	91	4	1		
7-24-30	30	1,000,000	36,000	7	88	3	2		
7-25-30	30	1,000,000	22,650	15	72	10	1	2	
7-26-30	30	1,010,000	26,000	12	72	9	2	3	BASO 2
7-29-30	35	1,020,000	27,800	15	75	7	2	1	
7-30-30	35	1,020,000	26,000	10	72	12	3	3	
7-31-30	35	1,030,000	49,200	12	72	9	2	3	BASO 2
8-1-30	35	1,360,000	36,800	10	76	10	2	2	
8-2-30	40	1,300,000	33,000	7	85	4	3	1	
8-4-30	35	1,410,000	24,000	41	47	9	2	1	
8-7-30	55	2,310,000	13,850	50	43	3	2	1	BASO 1
8-11-30	50	2,300,000	32,500	20	75	2	2	1	
8-13-30	50	2,350,000	58,250	5	85	7	2	1	
8-14-30	50	2,310,000	68,500	3	86	6	3	2	
8-15-30	50	2,300,00	78,350	3	96	1			
8-16-30	50	2,310,000	77,500	5	85	7	2	1	
8-18-30	45	1,980,000	135,000	2	85	10	3		
8-19-30	45	2,000,000	153,000	1	91	7	1		
8-20-30	40	1,800,000	142,000	2	90	6	2		
8-21-30	45	1,950,000	120,000	3	91	5	1		
8-22-30	45	1,960,000	98,600	4	89	6	1		
8-23-30	50	1,990,000	98,000	3	91	5	1		
8-24-30	50	1,900,000	128,000	2	91	3	4		
8-26-30	50	1,970,000	118,500	3	89	2	4	2	
8-27-30	40	1,250,000	265,000	1	95	3	1		

Fig. 6. Table of consecutive blood counts, showing remissions after nephrectomy Aug. 7, 1930 and gradual increase in leucocyte count to 265,000 before death.

Cut surface is smooth, grayish yellow with a few streaks and spots. Markings are indistinct in most pyramids. Pelvis not enlarged relative to size of kidney."

Microscopic Examination: The normal structure of the kidney is almost completely supplanted by a diffuse deposition of lymphocytes lying in a fine reticular stroma. The round cells have vesicular nuclei, in some places hyperchromatic, but no mitotic figures are seen. The remaining glomeruli and tubules are widely scattered and albuminous. Degenerative changes are marked.

Diagnosis: Diffuse lymphoma of kidney.

cytes, the latter reaching 98 per cent at one time. Five weeks after admission the patient expired.

An autopsy was performed by Dr. D. F. McClure with the following report:

External Examination: The body is that of a rather well nourished white female child of four years, of average build. The body is still warm, no rigor mortis present. Some post mortem hypostasis visible over the back. The hair of scalp is soft, brown and evenly distributed. Pupils are equally dilated. Ears and nose are normal. There is evidence of recent bleeding about the lips and gums. The skin is

pale and shows several small petechiae over the forehead and cheeks. There is a healed scar of a recent nephrectomy on the left side. There is a firm nodular enlargement of both parotids, not attached to the skin. The cervical lymph nodes are bean sized. Axillary and inguinal lymph nodes are enlarged to the size of lima beans. They are firm and discrete. The epitrochlear glands are small. The abdomen is distended. The spleen is 3 cm. below the ribs. The liver extends to the umbilicus. The lower pole of the right kidney reaches to the iliac crest.

Internal Examination. The main incision extends from 2 cm. below the suprasternal notch to the symphsis pubis. There is scant panniculus. The peritoneal cavity contains about 350 c.c. of clear straw-colored fluid. The peritoneal surfaces are clear and glistening excepting in the left lower quadrant where numerous dark red petechial hemorrhages are visible. There are fibrinous adhesions between two loops of gut in the left lower quadrant at the site of several small subserous hemorrhages. The omentum is adherent there to the appendix.

Liver: The liver extends 3 cm. below the umbilicus. The capsule is smooth. The color is finely mottled, light yellowish brown. On section several hard white areas are cut through, near the hilus. The vessels and ducts course through it unobstructed. The outline is roughly stellate.

Gall Bladder: The gall bladder is opaque-white in color. The serosa is smooth and glistening. The wall is ½ cm. thick and rather firm. In the fundus the papillae of mucosa appear enlarged. The cystic and common ducts are patent. A clear brown bile can be expressed from the papilla of Vater by pressure over the gall bladder.

Spleen: The spleen extends 3 cm. below the costal margin. It is firm in consistency. The capsule is smooth, grayish red. On section the pulp scrapes away with little difficulty. Near the hilus a firm white area is cut through, about 1 cm. in diameter. It has the appearance of growth by expansion.

Stomach: The stomach is partially distended by undigested food. The wall is soft. Numerous bean sized lymph nodes along the lesser curvature are firm and discrete. The mucosa shows a few petechiae. The jejuneum and ileum show very little change. Peyer's patches are not enlarged. Solitary follicles appear pinhead in size. Several petechiae and vibices are seen in the lower end of the cecum and at the base of the appendix. A recent blood clot is found free in the cecum. At the splenic flexure the mucosa show numerous small hemorrhages, up to 5 cm. in diameter and small pinhead sized ulcers. At the lower end of the sigmoid the wall is firm, homogeneous and white, up to 1 cm. thick, pushing the mucosa forward in the form of a broad based papilloma with hemorrhagic surface.

Appendix: The appendix is 7 cm. long and up to 1½ in diameter at the tip. The serosa shows several petechiae. The mucosa is ½ cm. thick.

Kidneys: The left kidney is missing. There is edema and slight injection of the tissues at the site of operation. The left adrenal is surrounded by edematous connective tissue. On section the cortex appears pale yellow with practically no zone of darker brown present. The proximal end of the lower half of the left ureter is held in young scar tissue medial to iliac vessels and close to the promontory of the sacrum. The right kidney extends to the crest of the ilium and to the midline of the abdomen. The capsule strips with ease revealing a smooth, pale yellowish-gray cortex, closely speckled with dark red petechiae and vibices. On section the cortex is opaque yellowish-gray throughout with numerous parallel streaks and spots. The normal markings are not very clear cut. The pelvic epithelium appears normal. The bladder contains clear yellow urine. Mucosa appears normal except for slight redness about the urethral orifices.

Pancreas: Pancreas is quite firm and is matted with enlarged lymph nodes. All the mesenteric retroperitoneal and iliac glands are numerous, discrete and firm and up to 1½ cm. in diameter. On section many show small hemorrhagic spots and streaks, on a firm white matrix.

Thorax: The thoracic cavity, organs not removed. There is no free fluid. Pleural surfaces are smooth and glistening.

Lungs: Both lungs are soft and crepitant. A few large mediastinal nodes are felt.

Thymus: Thymus is 9 × 5 × .2 cm. and extends down to the level of the third interspace.

Heart: Does not appear enlarged.

Microscopic Examination: Appendix: Mucosa and subserosa are densely infiltrated with lymphoid cells. Muscularis is only slightly involved.

Kidneys: Dense, homogeneous lymphoid infiltration of the stroma of kidneys, separates tubules and glomeruli widely. Tubular epithelium shows cloudy swelling. Here and there small interstitial hemorrahges are seen.

Gall Bladder: Rugae of mucosa are enlarged and filled with densely arranged lymphoid cells. Musculature is but little involved. Subserous infiltration is 6 mm. deep.

Lymph Nodes: Larger than normal. Germinal centers cannot be distinguished. A few small hemorrhages are interspersed throughout the dense lymphoid stroma.

Wall of Sigmoid: Submucosa is very deep and made up of fatty tissue surrounded by large areas of albuminous degeneration. Blood vessels are packed with lymphocytes. Lymphoid infiltration of the walls is not very marked.

Pancreas: Lymphoid infiltration follows the fibrous septa, separating the lobules. There is a moderate increase in the amount of fibrous tissue.

Spleen: Trabeculae are far apart. Sinuses contain many lymphocytes.

Microscopic Diagnosis: Diffuse lymphoma of Kidneys. Diffuse lymphoma of gall bladder. Lymphomatous infiltration of pancreas, spleen, appendix and lymph nodes. Acute lymphatic leucemia.

Clinical Diagnosis: Acute lymphatic leucemia.

Gross Anatomical Diagnosis: Acute lymphatic leukemia. Ascites. Petechial hemorrhages of mucous membranes of mouth. Petechial hemorrhages of the peritoneum. Petechial and submucous hemorrhage of the colon. Recent scar of left nephrectomy. Enlarged retroperitoneal and mesenteric lymph glands.

Diffuse lymphoma of right kidney.

Lymphomata of liver, spleen, gall bladder and pancreas.

I wish to express my thanks to Dr. S. J. Waterworth and Dr. D. F. McClure for their assistance in reporting this case.

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* Continued from p. 564.

TUMORS OF THE KIDNEY

WITH ESPECIAL REFERENCE TO THE HYPERNEPHROMATA*

LAWRENCE W. SMITH, M.D., AND HENRY W. FERRIS, M.D.

NEW YORK

INTRODUCTION

IT is our purpose to review, as briefly as possible, the pathological classification of tumors of the kidney, with the point in mind primarily of correlating these pathological diagnoses, where possible, with differential clinical prognosis, and indicating the pathologist's function in the field of genitourinary surgery.

For this purpose we have drawn our material from the service of the Brady Urological Foundation at the New York Hospital under Dr. O. W. Lowsley's direction, and from the other surgical services of the New York Hospital. And, it is through their kindness that we are able to present the specific cases as examples of the various types of tumor under discussion. In addition we have drawn freely on the various textbooks and published papers concerning these tumors over the past ten years, including so recent a presentation as that of Perla at the November meeting of the New York Pathological Society.

EMBRYOLOGY

We will presume for the moment to recall hastily the essentials of the embryologic development of the kidney in order to understand our classification of its tumors, for in hardly any other single group of tumors does Cohnheim's theory of cell rests play so prominent an etiologic part.

To summarize the embryologic studies of the origin of the kidney, as expressed particularly by Bremer,[1] it may be said that all the renal organs, pronephros, mesonephros (Wolffian body) and metanephros (mammalian kidney) are developed from the nephrotomes. In man the pronephros normally disappears, the Wolffian body itself atrophies entirely in the female, and in the male plays a part in the development of the epididymis, while the actual renal tissue is derived from the metanephros.

However, the Wolffian duct persists for some time and each duct near the place where it enters the cloaca forms a knob-like outpocketing which elongates rapidly, becoming the ureter. This, in turn, expands, becomes lobular and produces the pelvis of the kidneys, including the major and minor calyces and the collecting tubules with all of their branches.

The second part of the kidney which consists of dense mesenchyma subdivides into masses enveloping the enlarged tips of the collecting tubules to form vesicles. These elongate, forming s-shaped tubules, whose upper, outer ends unite with the collecting tubules and whose lower ends form the glomeruli with their capsules.

The adrenal, in turn, develops in two parts in man, the cortex appearing first. It is formed from cells which develop as buds of the celomic epithelium growing into the mesenchyma on either side of the mesentery, medial to the Wolffian bodies. The medullary portion is derived from chromaffin cells of the sympathetic ganglia growing ventrally along the medial side of these masses.

From this mode of development, it is obvious that accessory suprarenal glands may occur locally, or be carried down with the descent of the gonads into the epididymis or broad ligament. It is equally obvious that normally there is very little opportunity for adrenal cell rests to occur in the kidney.

* From the Department of Urology, James Buchanan Brady Foundation, New York Hospital, and from the Division of Laboratories, New York Hospital. Read before the meeting of the American Urological Association (New York Branch) Dec. 4, 1930.

Bothe,[2] however, in a recent article reviewing the embryology of this region, shows, as other investigators have, that

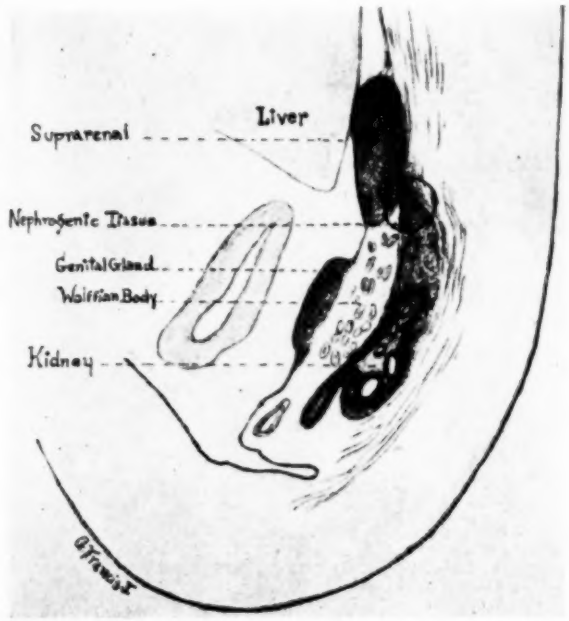

Fig. 1. Longitudinal section of a 16 mm. human embryo. (Modified after Wilson and Willis.)

in some cases there may be a time between the regressive phase of the pronephros and mesonephros when the nephrogenic tissue *may* lie in close proximity to the suprarenal body, and thus it is not impossible or even improbable that such adrenal rests *may* subsequently be found just beneath the capsule of the kidney and give rise to tumors presenting modified variations of the morphologic characteristics of adrenal cortex. This, by no means, indicates or even suggests that all tumors of the kidney cortex are adrenal in origin as many investigators would seem to believe.

CLASSIFICATION

Based on the embryologic origin recounted here of the various types of cells associated with the development of renal neoplasm, it is relatively simple to devise a workable pathological classification of these tumors. Broadly, they can be divided into two major groups: First, those in the renal pelvis, and second, those which are found in the cortex.

Pelvic Tumors: The pelvic tumors are less commonly encountered, and are well understood. There is little opportunity

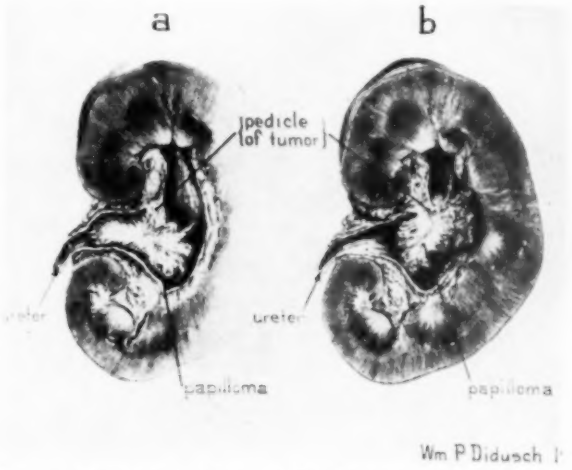

Fig. 2. Case No. 40635. Male sixty-two years. Papilloma of bladder showing distortion of pelvis.

here for discussion. They may be said to correspond quite accurately to the epithelial tumors of the bladder, being derived as they are from the same parent tissue. They may be divided into two chief types, the papillary and the squamous, but the former tumors may lose their papillary structure and become alveolar in form. Their malignancy may be quite accurately measured by histological gradation of their cellular mutation, the papillary form being the least invasive, and having the lowest mortality rate. The squamous form, on the other hand, unlike the papilliferous tumors, tends to invade more extensiveiy, even involving the blood vessels, and accordingly is not unlikely to be associated with distant metastases. Hunt and Hager[3] reviewed a series of 271 cases of malignant renal neoplasms, and found but 23 instances of the pelvic type of tumor, a total incidence of but approximately 1 in 12. In this series of 38 cases we have 6 examples of this type of tumor which would suggest that their figure is too low.

In our 6 cases we have a fairly representative series ranging from an essentially benign papilloma (No. 40635) in a man of sixty-two, through instances of varying

malignancy of the transitional type of epithelium up to a typical acanthoma (No. 36797) occurring in a man of fifty. Of these 6 examples 3 are known to be dead, 2 have not been traced, and only 1, the papillomatous case, is still known to be living. (This case was reported in detail by Dr. Kimball in the December, 1930, number of the AMERICAN JOURNAL OF SURGERY, and is included here through his courtesy.)

FIG. 3. Low power photomicrograph from same case. Transitional cell papillary epithelial masses, comparable to those seen in vesical tumors.

CASE HISTORY

CASE 1. No. 35458, J. S. a white man, forty-eight years old, was admitted to the New York Hospital, February 12, 1927, complaining of dull left lumbar pain, and sharp sticking pain near the outer border of the left rectus muscle of six weeks' duration. The latter was thought to be associated with constipation. He had never suffered any urinary disturbances. Physical examination showed only a questionable mass and tenderness in the left kidney region. The urine contained a few red blood corpuscles and clumped white blood corpuscles. X-ray showed a possible stone in the left ureter. Cystoscopy revealed no phthalein excretion from the left kidney. Left nephrectomy was performed. The specimen consisted of a kidney 15 cm. long. The pelvis and calices were considerably distended. A large portion of the pelvic wall was occupied by a solid white substance, in places 2 cm. thick, and projecting into the hilar fat tissue. On microscopic examination, showed compactly arranged sheets of cells with apparent attempts at pearl formation with prickle cells in places. Some carcinomatous invasion of the lymph channels of the hilum was found. There was also a chronic pyelitis.

FIG. 4. Case No. 36797. Male fifty-nine years. Typical acanthomatous type of squamous carcinoma of pelvis. Low power photomicrograph.

In general this group of cases is of particular interest clinically, as it is recognized relatively early through an associated hematuria, and characteristic pyelogram. Accordingly, its operative treatment is usually instituted at a favorable time, and three, five and even ten year cures are not at all infrequent in the literature.

Cortical Tumors: The cortical tumors are much more of a problem from the pathologist's standpoint, and even today we find no complete agreement as to pathogenesis. Certain names stand out in the history of their histologic study:

Waldeyer,[4] who in 1867 associated renal cancer with renal tubular epithelial changes, and Grawitz,[5] in 1883, who first conceived

Fig. 5. Case No. 36935. A typical case of adrenal type tumor, showing involvement of pelvis.

the notion of the possible adrenal origin of the yellowish tumors of the cortex; Birch-Hirschfeld,[6] who first introduced the term "hypernephroma" in 1892; Sudeck[7] in 1893; Stoerk[8] in 1908, and Wilson[9] in 1911, who disputed this relationship, and Wilms,[10] in 1899, who first recognized the embryonal nature of the sarcomatous tumors of childhood. Since that time no really important contribution has been made as to their pathogenesis, and the battle rages back and forth between these two major groups of extremists. And, as in most similar circumstances, the middle path is probably nearer the truth and both renal and adrenal elements may play a part in individual cases.

From our point of view, we are inclined to lean with Young,[11] and favor a generic term, such as "nephroma," as indicating a tumor of the kidney. This is in line also with Wilson's theory that these tumors are probably neither of suprarenal gland, nor of metanephrotic origin, but more likely are derived from the nephridial blastoma, which perhaps more readily might explain their usual occurrence just beneath the capsule of the kidney proper.

The principal difficulty which has to be overcome in determining the origin of this Grawitzian type of tumor histologically is in its polymorphism. Occasionally we find tumors in which the typical arrange-

Fig. 6. Same case. Pyelogram showing diagnostic deformity.

ment of the cells is indistinguishable from that of adrenal cortex, and in which this structure is uniformly found throughout the tumor. For the sake of argument, we might concede an adrenal origin of this type of tumor, based solely on morphology.

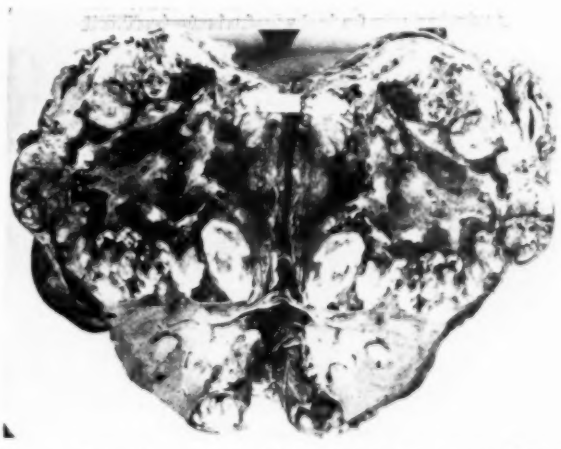

Fig. 7. Case No. 42408. Male fifty-three years. Gross specimen of rather large cystic, encapsulated adrenal type tumor.

Unfortunately, however, it is extremely rare to find such characteristic tumors. They are apt to be small, and more often found accidently at post mortem, than during life. Whereas, on the other hand, the usual and common kidney tumor is one in which typical adrenal appearing tissue

is admixed with areas showing definite tubule formation and often papillary proliferation of the cells. Some of the cells may

shall we do with the occasional morphologically indistinguishable papillary tubiform tumors when we find them in the

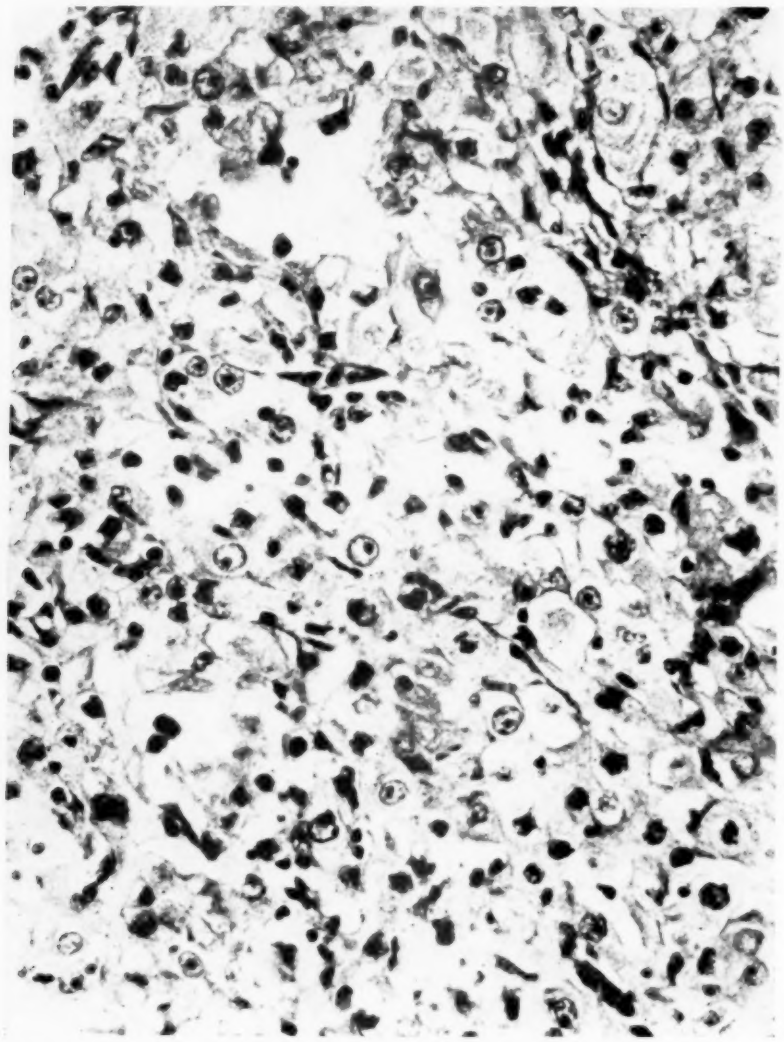

FIG. 8. High power photomicrograph of same, illustrating zona fasciculata arrangement of cells. Note also small nuclei and vacuolization of cytoplasm.

be "foamy," some "clear," while others may be distinctly "granular." Marked pleomorphism may be present. Irregularity in size and shape of cells is frequently to be noted, and it is difficult to concede a strictly adrenal "rest" origin to such a tumor.

But our difficulties do not end at that point. As Stoerk and others have suggested, the morphology of these papillary, tubiform neoplasms strongly favors a renal tubular epithelial origin, and the more generally accepted view today subscribes to this hypothesis. What then

adrenal? No one, we think, has had the temerity to even intimate that such tumors represent renal tubular epithelial "rests" in the adrenal. And so, having traversed the entire circle we come back to our starting point, what is the pathogenesis of these curious, more or less encapsulated, yellowish tumors which we find in the kidneys of middle-aged men and women?

We cannot concede, as Perla recently essays to, the Grawitzian hypothesis of all these tumors, nor can we admit the monophylistic hypothesis of renal epithe-

lial origin, and are forced to conclude that both tissues may play a part in the pathogenesis of this group of tumors.

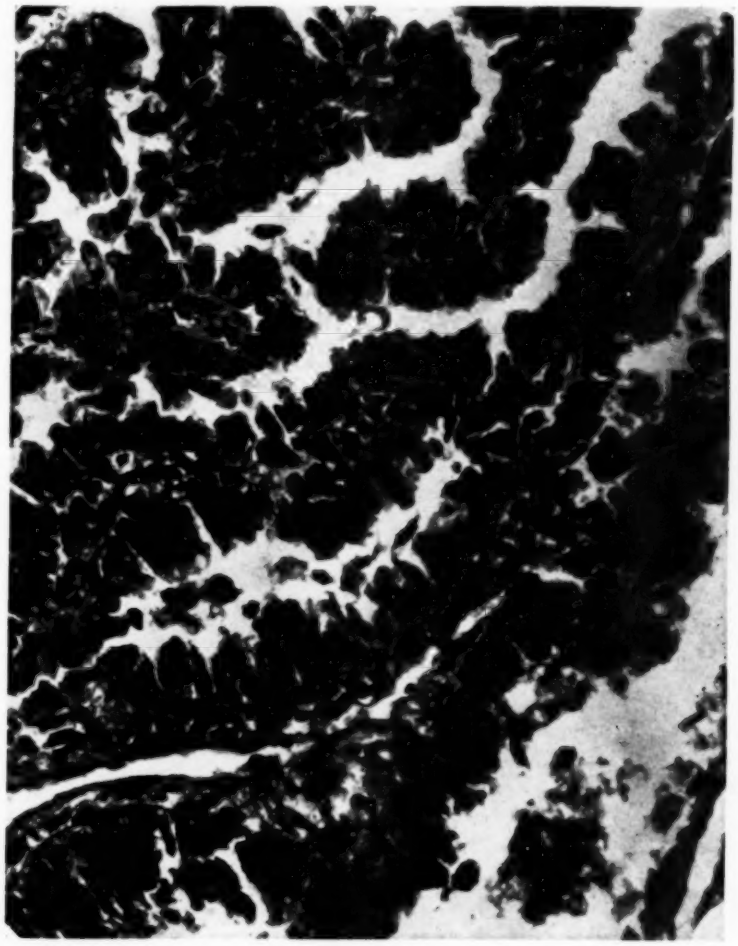

Fig. 9. High power, illustrative of granular type of papillary adenocarcinoma of kidney, quite unlike preceding case.

Dealing as we are with tissue all derived from such closely related mesothelium, Wilson's proposal to apply the term "mesothelioma" to them is perhaps as nearly accurate a plan as any. But, we feel that such a term is unsatisfactory as it does not express the very obvious differences in character of the developed tumors. It is quite possible that we may have actual tumors of adrenal rest origin, although the proof is most unsatisfactory. In the first place, the clinical evidence of virilism which is so apt to occur in true adrenal cortical tumors has not been reported so far as we are aware in a single case of *renal* "hypernephroma." Like the old familiar proverb, "all is not gold that glitters, certainly, all more or less encapsulated *yellow* tumors are not of adrenal cortical "rest" origin, as for example, the curious lipoidal, vacuolated cell tumors of the thyroid or breast, certain xanthomata and the like. From the rather insecure embryologic evidence, has been built an exceedingly top heavy house of cards, which justly, we believe, has fallen to the ground. Ewing[12] in his chapter on tumors of the kidney concludes that true adrenal rest tumors must be of comparatively infrequent occurrence.

And yet, we cannot dismiss the theory as entirely untenable and are inclined to feel that true adrenal tumors may occasionally occur. They present some differential features both histologically and clinically, which tend to segregate them into a definite pigeon hole. In our series

we have 5 cases which might reasonably be included in this group; of which the following are representative:

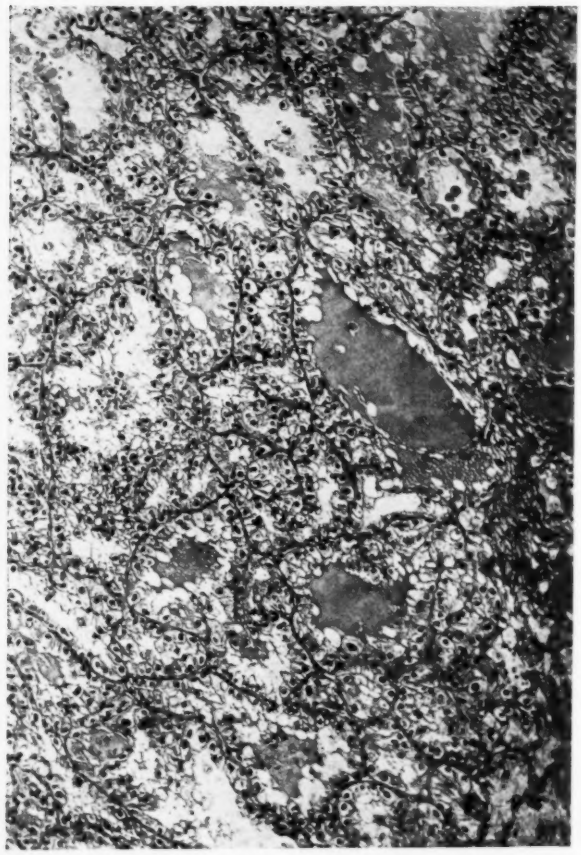

FIG. 10. Case No. 41331. Male fifty-two years. Illustrative of clear cell type of papillary adenocarcinoma, presumably of renal tubular epithelial origin.

CASE II. No. 42408, V. I., a white male of fifty-three was admitted to the New York Hospital September 24, 1930. For about eleven days his urine had been dark brown in color, and during the last few days had contained fresh blood. He had also had pain in the right kidney region. Physical examination showed nothing significant. His urine contained many red blood corpuscles. The phthalein excretion from the right kidney was 0.5 per cent in five minutes. Pyelogram showed a probable tumor. Right nephrectomy was done. The upper two-thirds of the kidney was occupied by an encapsulated mass 10.5 cm. in diameter. The tissue was soft, red and yellow. Microscopically, cords of foamy cells separated by delicate strands of connective tissue, were seen. The patient is alive at time of writing.

CASE III. No. 28032. W. J., a white male, fifty-three years of age, entered the New York Hospital April 3, 1922, complaining of loss of weight and strength, "bilious" attacks, and pain in the right upper quadrant of three years' duration. A pyelogram suggested a new growth in the lower left kidney. A nephrectomy was done. At the lower pole was found a tumor 6 cm. in diameter. On section yellow with streaks of hemorrhage and pale connective tissue. Microscopic preparations showed the cords of foamy cells with small nuclei of a "Grawitz" type of neoplasm. In 1923 he again entered the hospital for a cholecystectomy. In 1926 "a tumor attached to the ilium" was found, treated by *x*-ray, following a course of lead therapy at St. Luke's Hospital. He finally died in the Memorial Hospital, May 4, 1927. An autopsy showed metastases to the lungs, heart, pericardium, right kidney, bones, liver and peritoneal cavity.

In general, it may be said that as a whole, these tumors tend to remain encapsulated, and accordingly are more benign. They are apt to be smaller than the typical tumor of renal origin, but unfortunately do metastasize relatively early. Throughout their natural history their morphology is likely to remain relatively constant; masses of uniformly large "foamy" cells arranged in sheets or trabeculae as in the zonae fasciculata or glomerulosa of the normal adrenal. The nuclei are typically small and eccentric, and the cytoplasm lacks the clarity or the granular appearance of the other more usual form of tumor. Furthermore, there is a rather dense central fibrous core and the cords of the cells are often arranged about vascular sinuses as in the adrenal itself. The importance of their recognition histologically is because of their possibly more favorable prognosis.

We should not be inclined to argue too strenuously with anyone who maintained that even these tumors failed to qualify as of true adrenal origin, and merely represented a more completely differentiated type of the common or garden variety of cortical tumor, a type which might be graded histologically as of comparatively low degree malignancy. The point which

Perla made in this respect is of interest. He compares these "silent" hypernephromata with the "fetal" adenomata of the thyroid which histologically remain benign save for occasional invasion of the blood stream with the establishment of distant histologically benign metastases which may be the occasion for calling attention to the primary tumor.

On the other hand we have those tumors in which we feel a definite origin from renal tubular epithelium can be traced. And yet, here too, our evidence is chiefly circumstantial for certain links in the chain are lacking. Such tumors have been especially described by Ewing.

Among the well-recognized tumors of the kidney are the tiny hyperplastic adenomata usually found in the cortex of sclerosed organs, and often multiple. Here there is general accord as to their tubular epithelial origin. But, unlike other adenomata there is no great tendency toward malignant degeneration, and the intermediate stages between benign adenoma and frank adenocarcinomata is seldom found.

Whatever their pathogenesis, these cortical renal tumors form a very definite histological and clinical group. It is to this type of tumor that the misnomer "hypernephroma" has become inseparably attached in the minds of most clinical surgeons, and the attempts of pathologic purists to replace it by a more exact terminology is probably quite futile. However, there are subdivisions within the group, and their behavior in these divisions varies within rather wide limits. Of these variations in morphology, we have two fairly clear cut types; first the comparatively rare "granular" cell papillary tumors, in which the cells are deep staining, the cytoplasm almost homogeneous, the nuclei small and deep staining and cells arranged on rather heavy fibrous stalks; and second, the most common tumor of the whole series, the typically "clear" cell papillary adenocarcinoma. In these the cells are large, coarsely vacuolated, so that their cytoplasm is barely recognizable, except for the limiting membrane outlining it. The nuclei tend to be larger, often with

Fig. 11. Case No. 37085. Relatively small localized tumor of renal type. Shows characteristic loss of capsule.

a well defined nucleolus and definitely recognizable strands and granules of chromatin. The stroma is a delicate stalk composed of capillary vessels and a few supporting connective tissue strands. The lumina of the acini frequently contain a homogeneous pink staining colloid like material.

The tumors are apt to be extremely vascular with many areas of necrosis. They may attain considerable size, 10 to 20 cm. in diameter. They lack the characteristic central fibrous core associated with the "adrenal" type of tumor. In addition they are much less definitely encapsulated, often infiltrating irregularly not only the kidney substance, but the surrounding perirenal tissue. Like the hypernephroma they very commonly invade the renal vein, and extend along the inferior vena cava.

In our series we have 21 cases which we feel belong in this group, of which the following are representative:

Case iv. No. 41331 (6931). G. P., White male of fifty-two years, was admitted to the New York Hospital February 14, 1930 with a history of recurrent attacks of lumbar pain accompanied by hematuria. The first was five

years before. He had several such attacks in 1928. Physical examination produced no significant findings. Pyelography showed a picture

Fig. 12. Case No. 6434. Autopsy specimen from similar extensive involvement of one kidney in renal tumor.

suggesting a tumor of the right kidney. He was discharged February 17, 1930, but readmitted March 20, 1930, and a nephrectomy performed. The kidney contained a mass in its central portion, measuring $5 \times 5 \times 4.5$ cm. It was soft and reddish-yellow with white trabeculae. The growth seemed to be invading the veins. Microscopic sections showed acini and papillary structures with very clear cells lining the spaces or covering the delicate bands of stroma. Many of the acini contained clear pink staining material. There are small hemorrhages in portions of the stroma, which in places is very dense. He developed a bilateral bronchopneumonia and right empyema, and died ten days postoperative. Post-mortem examination revealed no metastases.

Case v. No. 39759. L. H. White male fifty-seven years old, entered the New York Hospital May 4, 1929, complaining of frequency, nocturia and attacks of left lumbar pain of four years' duration, and of hematuria present for one month. Physical examination showed a slightly tender mass in the left upper quadrant. Pyelogram showed a probable horseshoe kidney with stone in the left pelvis. At operation the left side of the horseshoe kidney was removed. An encapsulated soft tumor, 5 cm. in diameter was found at the lower pole. Section showed a yellow surface streaked with red. A large stone was present in the upper part of the kidney associated with pyelonephrosis. Microscopically the tumor was composed of rather solidly arranged clear cells, but with definite papillary and acinar arrangement in portions. The patient was still living in March, 1930. This case is recorded through the courtesy of Dr.

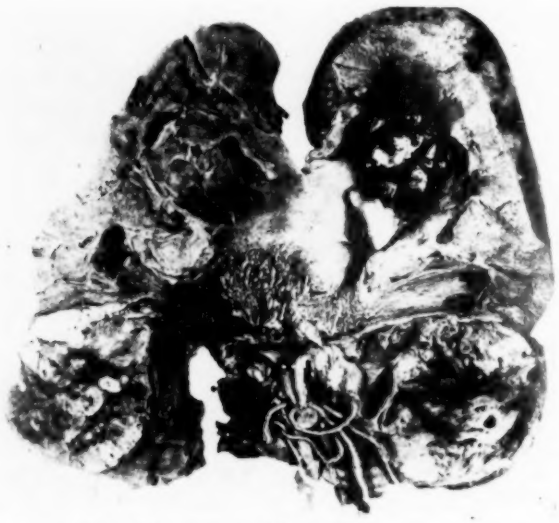

Fig. 13. Case No. 39759. Male fifty-seven years. Case of Dr. DeVries. Horseshoe kidney, showing tumor in lower pole and nephrolithiasis in upper pelvis.

John de Vries, the attending urologist. It is particularly of interest because of its occurrence in a horseshoe kidney and its association with stone.

Including the 5 possible adrenal tumors, the statistical study of these 26 cases may be briefly summarized The average age. was 55.7 years, the extremes being a young woman twenty-seven, and a man seventy-seven years of age. There were 18 males and 8 females. The right side was involved thirteen times, the left thirteen times. The tumor was in the upper half of the kidney ten times, in the lower half eleven times. In the remaining 5 cases the location was either not stated or the tumor was described as being in the mid-region. Stone was found twice in association with pyelonephritis and the tumor.

Nephrectomy was performed in 24 of the 26 patients. The other 2 cases were found incidently at autopsy. Five of the patients are still living, 11 have died, and the remaining 10 have not been traced completely. Four of them, however, were alive two to three years postoperatively.

Clinically, the presenting symptoms were: *pain*, which occurred in 24 of the

cases; *hematuria*, which was present in 15 instances, and the presence of a subjectively recognized *tumor* in 6 of the cases. The duration of symptoms varied greatly, the extremes being eight days and seventeen years. The usual story was a matter of several weeks or months. The diagnosis was confirmed in most instances by pyelography and operative measures carried out as indicated.

In addition to the 26 cases cited here are 6 others in which the data are incomplete, but in which there is little doubt as to the diagnosis, and which we feel could be included in this group of renal carcinomas.

EMBRYOMA

Finally, there is the important group of tumors occurring almost entirely in the first decade of life, the embryonal tumors of Wilms, often spoken of as sarcoma, adenosarcoma, adenomyosarcoma, or mixed tumors of the kidney. Wilms' original conception of these tumors required the inclusion of nephrotome, sclerotome and myotome to account for the wide variation in the histology of the developed tumors. Muus[13] accredits the origin simply to the renal blastoma, as do Wilson, Glynn,[14] Young and others, who feel that this mesothelium is fully capable of differentiation into the various elements of the tumors. The difficult feature to account for is the frequent presence of smooth or striated muscle and many investigators are in accord with Wilms' original theory that at least myotome inclusions must be present. Ribbert[15] even goes so far as to believe that they are true teratoid tumors and must be derived from aberrant sex cells. Again, their pathogenesis is a matter of academic dispute and of little practical importance. Their recognition clinically is comparatively simple. Their occurrence in infants and their relatively and actually enormous size, some of them attaining a diameter of as much as 35 cm. is very suggestive. Their gross appearance is also characteristic. They tend to be solid, opaque, whitish tumors, well encapsulated, and infrequently showing metastasis. As they increase in size they become cystic and less easily identified, especially when found in adults.

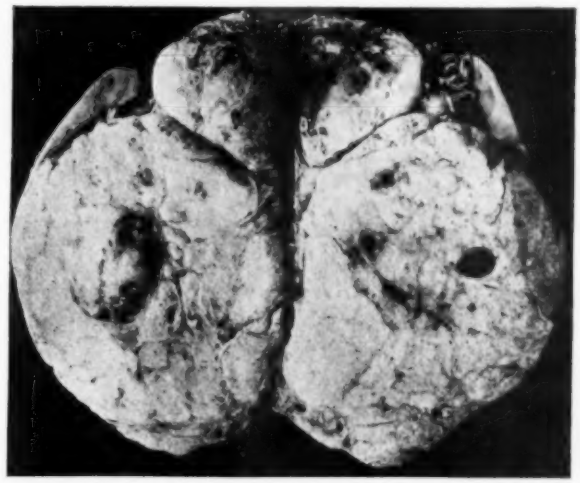

Fig. 14. Case No. 18376. Kidney from infant of three months, showing extensive replacement of renal tissue of embryonal tumors. Wilms' embryoma.

Among these tumors may be cited a rather well-defined group of cases designated as embryonal adenocarcinomata and occurring usually in young adults. We are inclined to feel that they are merely a curious one-sided, late development of this same general type of embryomata. The following are representative histories:

Case vi. 18376 T. J. Male, aged two and one-half years, was brought to the New York Hospital June 10, 1915. Eight months before his father had noticed a firm, hard lump in the lower part of the child's abdomen. This mass increased in size, and the child lost some weight. Physical examination showed this mass to be about 6 in. long, in the left kidney region, and freely movable. The urine showed no red blood cells. A left nephrectomy was performed. The specimen presented a new growth about the size of a cocoanut, irregularly ovoid, and occupying a position between the two poles of the kidney. A thin layer of parenchyma connected these poles. The tumor seemed to be in two parts. The general color of the larger part was greyish yellow, with portions resembling brain tissue. The smaller portion,

which was hemorrhagic, encroached on the pelvis. Microscopic sections showed a relatively loose, but fairly cellular stroma, which

Fig. 15. Case No. 40274. Curious case in woman of forty-nine in which a tumor clearly of renal origin was present at one pole and this unusual tumor in the other pole. Shows what we interpret as a relatively undifferentiated renal blastoma, tending to develop adenomatous area.

in places suggested smooth muscle strands. Masses of dark staining more rounded cells were scattered here and there and throughout were found small tubular structures lined by cuboidal cells, with dark nuclei. The postoperative course was complicated by measles. He had two subsequent admissions for recurrence of the mass in his abdomen, with evidence of free fluid. He became weaker, and died December 29, 1915. Autopsy was not permitted.

Case vii. No. 14235. A. S. A white female thirty-four years old, entered the New York Hospital July 13, 1911 because of a lump in the right side of her abdomen, noticed ten weeks before, just after the birth of her youngest child. The lump increased gradually in size, and she also suffered some obscure right-sided pain. She had grown thinner. Physical examination revealed malnutrition and some anemia. The abdominal mass, the size of a cocoanut, extended up into the right hypochondrium, and seemed attached to the kidney, or under surface of the liver. It could be moved from side to side, but not up and down. The urine contained no red blood corpuscles. An exploratory laparotomy was done and a tumor extending up under the liver found. Two pieces of tissue removed from the anterior surface showed microscopically renal tiseus.

After a rest in the country, she entered the hospital again September 8, 1911, when right nephrectomy was performed. The removed

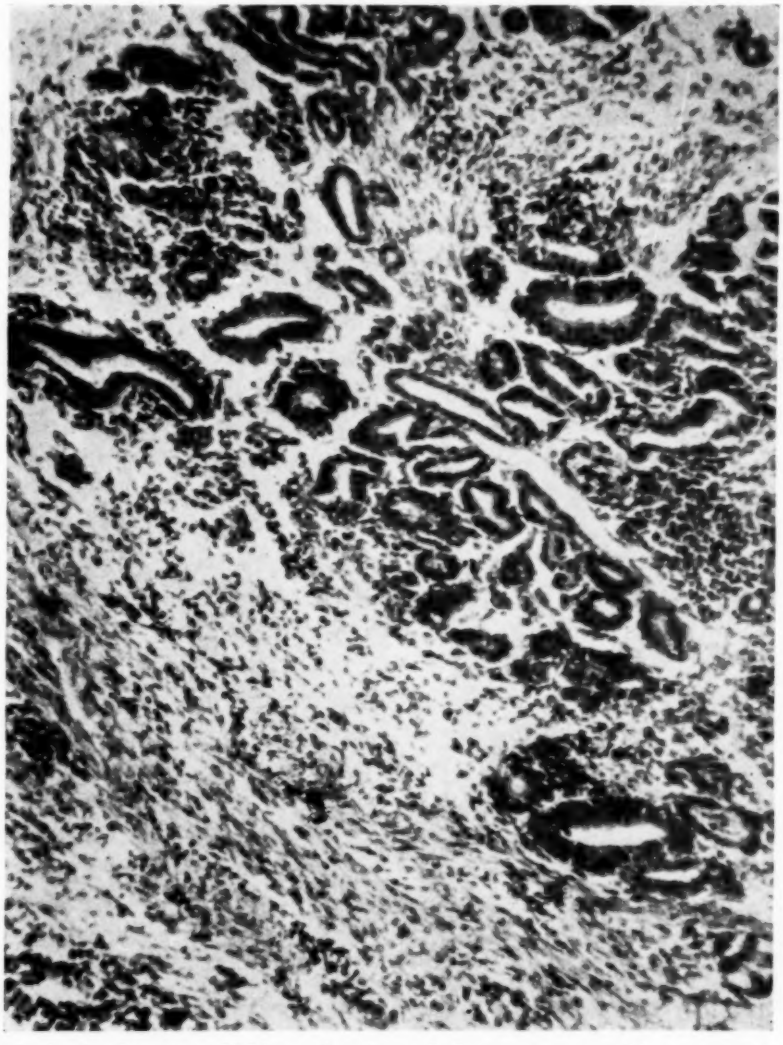

Fig. 16. Typical mixed tumor of kidney showing tubular structure amid a sarcomatous stroma.

specimen was about 24 × 14 × 8 cm. The kidney was flattened out on one surface of this mass, but seemed to fuse with the growth, which was irregularly lobulated, soft, yellowish. Microscopically the tumor showed a picture much like that seen in case No. 18376, with mixed sarcomatous and carcinomatous appearance. In 1926 she was reported to be alive, but under care of a physician for abdominal trouble.

Microscopically the tumors vary greatly, some of them being almost uniformly composed of undifferentiated renal blastemal cells, others showing pseudoglomerular and tubular formation. They usually contain muscle fibers of the striated or smooth type. Typically their stroma presents a sarcomatous degeneration. They have a curious tendency to be bilateral and accordingly fatal, but when unilateral, they may be relatively benign clinically, and a few permanent cures have been recorded.

In our series we have 6 cases which fall into this group, one of them occurring in an adult, the others all in infants or young children. They range from an almost undifferentiated blastoma to completely differentiated adenomyosarcoma. Four of these patients died within one year postoperatively. One patient was still living

fifteen years later, and one has not been traced.

In addition to these relatively frequently encountered tumors there have been described many others of no significance in a discussion of this sort: lipoma, myxoma, chondroma, fibroma, etc. Among these may be cited the curious tumor described by Warren[16] of a myeloid replacement of the renal pelvis.

Of the metastatic tumors the ones of particular interest are the paraganglioma and neuroblastoma of adrenal medullary origin. In some instances these tumors may appear primary and simulate hypernephromata, but careful study will usually reveal their true adrenal source. One such case was encountered in our studies, but not included in the series. Usually their identification is not difficult. They are invariably fatal by the time renal involvement has taken place.

SUMMARY

We have attempted to review briefly the more important primary tumors of the kidney and arrange them in a somewhat arbitrary classification for purposes of discussion.

In the first group we have the varying forms of papillary and squamous epithelial origin. Their malignancy can be quite accurately estimated histologically and a reasonably intelligent prognosis made.

In the second group, composed of the vast majority of the cortical tumors of individuals past middle life, we are inclined to accept the conventional classification of two major types: one, arising from adrenal rests; the other being derived from renal epithelium. Of this first type, there are but very few unquestionable examples. Of the second type we have several arbitrary subdivisions; chiefly the papillary, composed either of clear cells or of granular cells, and the rarer alveolar carcinoma. We are inclined to feel that these tumors all have a common origin, probably from some prenephric rest, and that the differences are inherently due to the particular reaction of the individual rather than to any fundamental difference in the cells of origin.

It is not important clinically to know whether a tumor arises from displaced celomic lining cells, or from nephridial rests, except as its clinical behavior varies. In these tumors no inherent differences are apparent in their clinical course except in degree. Tumors of presumable adrenal origin are apt to be slower growing, but may metastasize by the blood stream very early. They perhaps represent slightly more differentiated epithelium than do the tumors of renal origin, but their fundamental cell prototypes are essentially the same, which brings us to the conclusion that Wilson reached twenty years ago, of the underlying mesothelial origin of the entire group.

Finally, in reviewing the embryonal tumors of infancy and childhood, we are in accord with the current theory that they are of renal blastema origin. We feel that the evidence is sufficient to show that these cells are capable of differentiation even into the bizarre and curious, almost teratoid tumors which we occasionally find. It is but a step from accepting the conception of the origin of the embryonal tumors to recognizing that the adult hypernephroma may well arise merely from a later stage of differentiation of the renal blastema. Certain of the tumors we see most assuredly support such an hypothesis. We are inclined to leave the whole problem at this point, merely indicating the present trend of thought, until some keen observer comes along and finds an entirely new method of approach to our understanding of neoplasms in general, and of these inexplicable tumors of the kidney in particular.

[For References see p. 551.]

RESECTION OF THE KIDNEY

REPORT OF SIX CASES*

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RESECTION of the kidney has been practiced by various operators at occasional intervals for many years. As a result of improved technique and more intensive efforts at conservation in all forms of renal surgery, it is coming to be more and more commonly employed. Obviously the operation is best adapted to pathological lesions associated with congenital anomalies, such for example as horseshoe kidneys, bifid pelves, etc. It has, however, a place in some cases not associated with congenital anomalies such as benign tumors, solitary cysts and calculous pyonephrosis involving one pole of an otherwise fairly good kidney.

While it is conceivable that certain cases of tuberculous or malignant neoplasm located in one-half of a horseshoe kidney might be considered as suitable cases for resection, (I am not familiar with any such cases in the literature) such lesions would in most instances preclude such an operation. Resection should never be employed for malignant tumors or tuberculosis in any kidney not the seat of a congenital malformation. The special dangers incidental to the operation are of course, hemorrhage, primary or secondary, infection and persistent urinary fistulae. Hemorrhage and infection should be easily taken care of by means of proper suturing and adequate drainage. The suture-line should be covered with fat pads and the kidney pelvis should be drained through the cortex by means of a rubber tube. Urinary fistulae may persist for a while but I believe they all close eventually. Because of the danger of infection and persistent fistulae, these cases should be approached, if possible, by the extraperitoneal route. In some cases, such as the solitary pelvic kidney, it may be necessary to go through the peritoneal cavity.

Our group of 6 cases consisted of 1 solitary pelvic kidney, 2 horseshoe kidneys, 2 large solitary cysts and 1 case of calculous pyonephrosis occurring in a bifid kidney. There was 1 death, the pelvic kidney, from pneumonia on the fourteenth day after operation. In 1 other case, horseshoe kidney, a urinary fistula persisted for nine months followed by complete recovery. The other patients made uneventful recoveries.

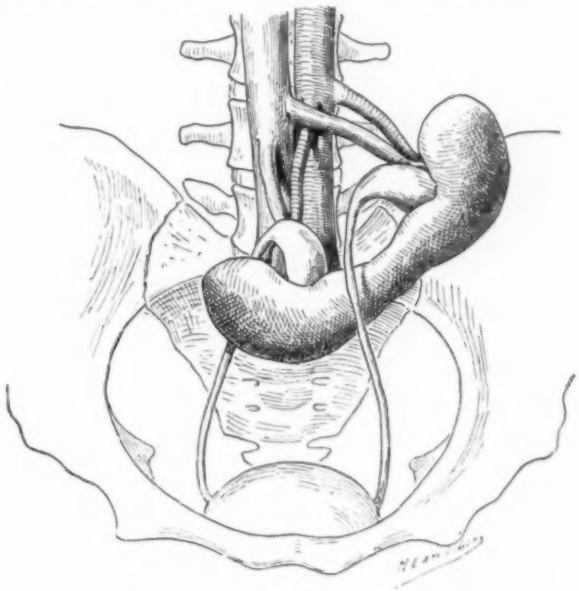

FIG. 1. Conditions found in Case 1.

Following is an outline history of our cases; positive findings only are noted.

CASE 1. M. W., female, aged fifty, married, no children, no pregnancies, menstruation established at sixteen, menopause at forty. Menses had always been regular but associated with severe cramps. For past ten years has suffered from severe lower abdominal cramps and bearing down sensation. For past year these pains have recurred at more frequent intervals and are terrific in character. During this time there has been a little frequency of urination and on two occasions the patient states that there was a little blood in the urine.

* From Brooklyn Hospital Urological Service.
Read at a meeting of the Brooklyn Urological Society, December 18, 1930.

Examination: Hemoglobin 37 per cent.

BLOOD CHEMISTRY

Urea	27.18
Creatinine	1.75
Sugar	166
Co_2 combining power	63

Wassermann test negative

Pelvic Examination: the uterus is normal in size and position and is movable. Behind the uterus, deep in the pelvis, there is a large fixed mass very tender to pressure.

Cystoscopy: the bladder is moderately trabeculated, otherwise normal, the ureter orifices are normal and in normal position. No. 5 catheters pass readily 6 in. on right, 7 in. on left. Clear urine flows in normal rhythm from each side. Phenolsulphonphthalein output normal on left, slightly reduced on right. All specimens of urine are sterile and show no abnormal ingredients except an occasional hyalin cast. Urea content right 2.77, left 10.08.

X-Ray Report: no right kidney shadows noted, very large low left kidney, both catheters pass to left, the left catheter very much to left. Unfortunately these pictures were destroyed and are not available. *X*-ray diagnosis, "Solitary pelvic kidney or horseshoe kidney."

Operation, January 14, 1921: 6 in. right rectus incision. A very large solitary kidney was readily palpated, extending from above the crest of the left ilium deep down into the hollow of the sacrum. Figure I shows diagrammatically the condition noted. The cecum and ascending colon were mobilized, the pelvic portion of the kidney exposed and rather easily resected. A wedge-shaped incision was carried into the upper half of the kidney and the incision closed with mattress sutures and a free fat transplant over the suture-line. This effectively controlled all bleeding. The abdominal wall was closed in layers with a cigarette drain at the lower angle. The operation consumed one hour and the patient left the table in good condition. There was considerable abdominal distension for a few days, readily controlled by the usual measures and on the seventh day she appeared to be progressing smoothly except for a wound infection. On the night of the seventh day the wound burst open throughout its entire length and several coils of small intestine were extruded into the dressing. She was given morphine and immediately brought to the operating room, where under gas anesthesia the bowel was replaced and the wound resutured. She took her anesthetic badly and the operation was extremely difficult, requiring one hour and fifteen minutes of anesthesia. The following day she had an extensive bronchopneumonia and died six days later, fourteen days after her first operation. I have always had a feeling that a spinal anesthesia for the second operation might have saved the day.

Case II. T. P., single, male, aged twenty-six, for past two years has had urethral discharge and cloudy urine, was treated in another clinic for several months a year ago with urethral injections and irrigations. For the past two years occasional dull ache referred to left flank.

Examination: left kidney palpable, enlarged and tender.

BLOOD CHEMISTRY

Urea	25.4
Creatinine	1.50
Sugar	100

Cystoscopy, Sept. 12, 1923: Extensive diffuse cystitis, ureter orifices normal and normally situated. No. 5 catheters pass easily to each kidney pelvis. Clear urine flows in normal rhythm from right side. Cloudy urine in a steady drip from left side. Phenolsulphonphthalein normal for right, no dye from left. A left pyelogram was made. *X*-ray findings, low right kidney, left kidney large with a marked hydronephrosis (Fig. 2).

Operation, Sept. 24, 1924: 7 in. oblique loin incision. The kidney is apparently converted into a sac, difficult to mobilize, particularly at lower pole. After considerable floundering around it finally became evident that the sac was continuous with normal appearing kidney tissue extending across the vertebral column and the diagnosis was obvious. There was no definite line of demarcation between the two halves of the kidney. Resection was performed, carrying the incision in a deep wedge into healthy tissue and opening into a healthy calyx.

The kidney wound was closed with mattress sutures with a free fat transplant over line of incision. No drain was placed in the kidney stump. This was an error. The patient had rather a stormy convalescence, complicated by an extensive Welch bacillus infection. This was combated by opening the loin wound throughout its entire extent, Carrel-Dakins dressings and perfingens serum intravenously

FIG. 2. Left pyelogram showing practically complete destruction of kidney.

FIG. 3. Right pyelogram, same patient as in Fig. 2 showing right half of horseshoe kidney.

FIG. 4. Left pyelogram showing practically complete destruction of kidney. Suggestive of horseshoe kidney.

FIG. 5. Same case as Fig. 4, right pyelogram proving horseshoe kidney.

On Oct. 6, 1923 a pyelogram was made of the right side (Fig. 3). This is a typical horseshoe kidney pyelogram and had it been made

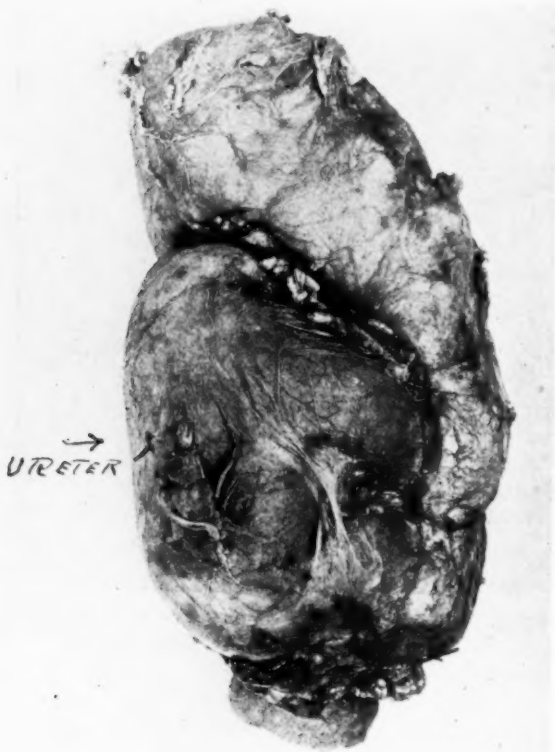

Fig. 6. Kidney removed from patient shown in Figs. 4 and 5, showing much dilated pelvis and parenchymal band forming union with other half of kidney.

before operation would have completed our diagnosis and saved us some anxious minutes during the operation. The patient was discharged from the hospital on Nov. 2, 1923 with a small sinus still draining considerable urine. This sinus persisted for nine months when it finally closed and the patient has remained well to date.

Case III. R. C., female, aged twenty, single, for past year frequency of urination, on two or three occasions a little blood in urine, for past four days rather severe pain in left loin.

Examination: left kidney palpable, enlarged and very tender, some rigidity of lumbar muscles. Temperature normal, white blood corpuscles 15,600, polymorphonuclears 82 per cent.

BLOOD CHEMISTRY

Urea	47.5
Creatinine	2.13
Sugar	129
CO_2 combining power	59

Cystoscopy: Oct. 6, 1927, mild diffuse cystitis, ureter orifices normal and in normal location. No. 5 catheters pass readily to each kidney pelvis. Clear urine in normal rhythm from right kidney, cloudy urine in slow steady drip from left kidney. Phenolsulphonphthalein right kidney normal, no dye from left kidney, urine from right kidney free from pus and sterile. Urine from left kidney shows many pus cells and culture shows colon bacilli. A pyelogram was made of the left kidney. *X-ray report:* both kidneys appear low, left kidney large, outline of lower pole not made out. Pyelogram shows a marked degree of hydronephrosis. Diagnosis, left hydronephrosis (Fig. 4). On Oct. 11, 1927 a pyelogram of the right kidney (Fig. 5). This showed the typical picture of a horseshoe kidney and confirmed the diagnosis.

Operation: Oct. 14, 1927, 6 in. left loin incision, the kidney was readily exposed and was fairly easy to mobilize except at lower pole which was attached to a broad band partly fibrous and partly parenchymal, which extended across the vertebral column. This band was clamped with a heavy clamp, divided, and the kidney removed (Fig. 6). Several suture ligatures of chromic gut were applied to the stump and the loin wound closed in layers with a raffia drain at the dependent angle. There was very little urinary leakage; the patient made an uneventful recovery and was discharged to her home on the fifteenth day.

Case IV. V. D., female, married, aged fifty-seven. A few days ago rather severe pain in right loin followed by frequency and dysuria, which has persisted. Patient states that at one occasion she noted a little blood in urine. Four months ago she had a similar pain in left loin which persisted for two months.

Examination, right kidney palpable, much enlarged and slightly tender.

BLOOD CHEMISTRY

Urea	38.7
Creatinine	1.85
Sugar	104.1

Cystoscopy, Dec. 17, 1924: Bladder and ureter orifices were normal and No. 5 catheters passed easily to each kidney pelvis. Clear urine flowed in normal rhythm from each side. Phenolsulphonphthalein was normal and equal on the two sides, urine from the right kidney was free from pus and sterile. Urine from the

left kidney showed a few pus cells and was also sterile. A pyelogram was made of the right kidney.

Examination: The right kidney is enlarged and tender. Hemoglobin 66, white blood corpuscles, 8800, polymorphonuclears 66 per cent.

Fig. 7. Right pyelogram showing filling defect of upper calyx caused by pressure of cyst.

Fig. 8. Rather faintly showing tumor mass connected and continuous with lower pole of left kidney.

X-ray report, the lower pole of the right kidney is much enlarged, the pelvis is small and the lower calyx is distorted. Diagnosis: Renal tumor (Fig. 7).

Operation: Dec. 19, 1924, 7 in. right loin incision. There was a cyst the size of a grapefruit springing from and partially including lower pole of right. This was excised, together with a wedge-shaped segment of kidney tissue. The kidney wound was closed, with mattress sutures and a free fat transplant over line of incision. Neither the kidney pelvis nor calyx was invaded and no drain was placed in kidney. The patient made an uneventful recovery. She reported again four years later complaining of some pain in left loin and moderate frequency of urination. Examination was essentially negative except for delayed emptying time of left kidney pelvis. She reported that she felt better after the cystoscopy and has not reported since.

Case v. B. C., female, married, aged fifty-five. Chief complaint pain in right loin for two years.

BLOOD CHEMISTRY

Urea	37.1
Creatinine	2.63
Sugar	116

Cystoscopy, May 14, 1926. Bladder normal, ureter orifices normal, No. 5 catheters pass readily to each kidney pelvis. Phenolsulphonphthalein a little below normal on each side. Urine from left kidney is normal, urine from right kidney shows a few pus cells and colon bacillus on culture. A pyelogram was made on the right side.

X-ray findings: the right kidney is much enlarged, the enlargement involving principally the upper pole, the upper calyx is partially obliterated (Fig. 7).

Diagnosis: Renal tumor. Pyelogram of the left kidney was normal and radiographs of the bony skeleton failed to show any metastases.

Operation, May 21, 1926, 6 in. loin incision. There was a cyst the size of large orange involving upper pole of kidney. The whole kidney, including the cyst, was placed high up under the ribs and was extremely difficult to mobilize.

During the operation an accidental tear was made in the pleura, which was repaired with sutures and a free fat transplant. An elastic band was placed around vascular pedicle for temporary hemostasis and the cyst excised as in the previous case. This patient also made an uneventful recovery.

Fig. 9. Calculus in lower pelvis of left kidney. Both ureters and both pelvis are reduplicated.

Case vi. B. O., female, single, aged thirty-six. For the past three years she has had a dull intermittent ache in right loin, pus in the urine and moderate frequency of urination. She was cystoscoped at several intervals over a period of two years, was advised on several occasions to have an operation but postponed it from time to time. She had a mild general diffuse cystitis. She had a complete reduplication of both ureters and a double pelvis on each side. In the lower pelvis of the right kidney there was a fairly large discrete calculus and this pelvis was considerably dilated (Fig. 9). The urine from this pelvis contained pus and colon bacilli. The urines from the other pelves were normal. Her blood chemistry and phenolsulphonphthalein output were normal.

Operation: July 11, 1930. The right kidney was readily exposed and delivered through a 6 in. loin incision. The calculus was removed through a posterior pyelotomy. Passing a finger into the pelvis it was noted that the corresponding cortex was very thin and resection was decided upon. While there was no line of demarcation between the two halves of the kidney, it was easy to isolate a separate blood supply. The vessels and the ureter were ligated separately and the lower half of the kidney resected, using a wedge-shaped incision carried into the healthy kidney but not invading the pelvis or any of the calices. The incision in the kidney was repaired with mattress sutures of plain gut and a free fat transplant over the suture-line. She made an uneventful recovery, except for an intermittent urinary fistula, which persisted for ten weeks, when it closed permanently.

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*Continued from p. 467.

A PROSTATE PACK FOR CONTROLLING HEMORRHAGE FOLLOWING PROSTATECTOMY*

HAROLD L. FOSS, M.D., F.A.C.S.

DANVILLE, PA.

THE control of hemorrhage following prostatectomy, whether the operation is performed by the perineal or suprapubic route, has always been one of the important and, frequently, difficult problems of the procedure. With good exposure it is not difficult of solution and there are many methods used to control the bleeding, most of which are usually successful. The Hagner and Pilcher bags are favored by many and they usually satisfactorily control the oozing from the prostatic bed. Some surgeons prefer to use a small gauze pack which is but loosely applied but which, unfortunately, usually floats out into the bladder as it fills with urine, rendering the hemostasis ineffectual. Some surgeons, performing the suprapubic operation, never resort to bags or packs, relying on carefully placed sutures.

FIG. 1. Removing tags of capsule of prostate after enucleation.

In the past fifteen years I have tried nearly every method that has been at all popular and for some years relied entirely on the Pilcher bag. In 1923 I described an accordion plaited pack which was a modification of others which had been similarly

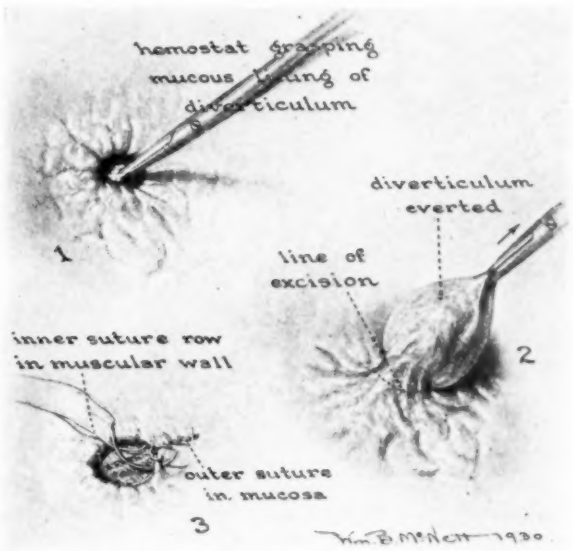

FIG. 2. Removal of vesical diverticulum in three stages.

designed and which I have found more satisfactory than any other means of controlling bleeding following the usual suprapubic prostatectomy. A few months ago I modified this pack somewhat and now, in its perfected state, it is proving so satisfactory that I felt it was worth while to again bring it to the attention of the profession. Its construction and application will be readily understood from the accompanying drawings.

With good exposure, and this does not necessarily mean a large bladder incision but one the margins of which are well retracted by means of properly designed bladder retractors, the prostate is enucleated and its bed carefully inspected. Redundant tissue or small adenomata which otherwise might be overlooked are carefully removed as illustrated in Figure 1.

The bladder is carefully examined for

* Submitted for publication January 17, 1931.

calculi which are removed and for diverticula, so frequently present, which are excised according to the technique illustrated in Figure 2. The bladder is then finally inspected under the brilliant illumination of a Cameron or similar light as shown in Figure 3. An occasional mattress stitch is placed in the margin of the prostatic bed if there is arterial bleeding although this is rarely necessary. The pack used is illustrated in Figure 4. It is made up in three sizes, No. 1, No. 2, and No. 3 for prostatic cavities of different sizes, No. 1 and No. 2 being the ones most frequently used. The dimensions are:

Fig. 3. Inspection of site of prostate with Cameron light.

No. 1—26 in. × 2½ in.
No. 2—36 in. × 3 in.
No. 3—42 in. × 3½ in.

The pack is made of eight thicknesses of gauze folded back and forth as illustrated and through which a strong tape, similar to umbilical tape, is passed and permitted to thread. One extremity of the pack is sewed tightly with silk to the tape, the other end and the intervening plaits being permitted to slip freely as the pack is drawn together and compressed. In cutting the eight lengths of gauze they are tapered slightly from the middle towards both ends of the piece which gives the completed pack pointed extremities, thereby greatly facilitating its introduction and, especially, its subsequent removal. The pack is applied through the suprapubic wound and the tape pulled tightly through the urethra so that the pack ultimately fits snugly within the prostatic capsule where it is kept firmly in place by means of steady traction made upon the tape. The pack readily unfolds and is easily removed through the small wound which is left for the suprapubic tube at the operation.

Fig. 4. Prostatectomy, hemostatic pack.

Figure 5 illustrates the method of introducing the pack. An ordinary steel urethral sound, through the end of which a slot has been cut, is used in withdrawing it.

Figure 6 illustrates the insertion of the pack. As traction is made on the tape by an assistant the surgeon, using a pair of long dressing forceps, carefully adjusts the folds of the pack following which all bleeding is permanently controlled.

Figure 7 shows a tripod, similar to the one used by many surgeons in supporting the Pilcher bag, placed in contact with the patient's perineum and groins and utilized to maintain firm traction upon the tape and pack. The tape is held in position at the apex of the tripod by means of a hemostat. The other end of the tape is

left lying upon the abdomen, having been brought out through the suprapubic wound. In thirty-six hours the hemostat

Fig. 5. Sound introduced and tape passed through slotted end.

is removed and tension on the pack released. In forty-eight hours the urethral portion of the tape is cut and the suprapubic portion drawn upon and the pack entirely removed as shown in Figure 8.

Following its removal together with the

Fig. 6. Introduction of prostatic pack.

suprapubic tube, a retention catheter is passed and the suprapubic wound permitted to close. Whether or not irrigations are begun will depend on individual taste. Many, Cecil among them, object to it. However, we feel it to be an advantage, using weak solution of mercurochrome daily and changing the catheter every third day. With this technique postoperative hemorrhage cannot possibly occur

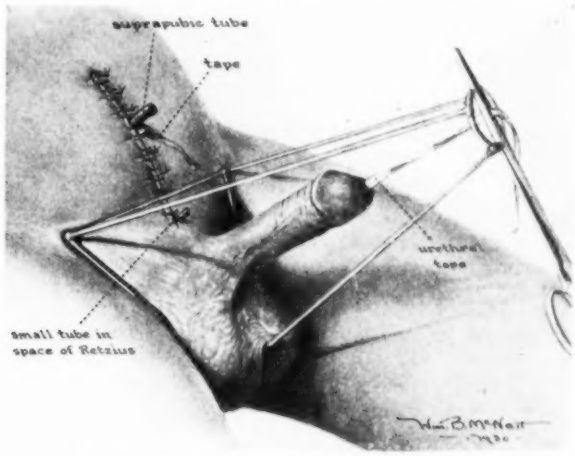

Fig. 7. Urethral tape secured by hemostat.

and the suprapubic sinuses will close as promptly as by any method yet devised. We formerly used various types of vacuum devices for keeping the bladder dry, only to discard them and to rely entirely on gravity through the indwelling catheter.

The pack was formerly made of plain surgical gauze but of late we have used iodoform gauze, it being fully as satis-

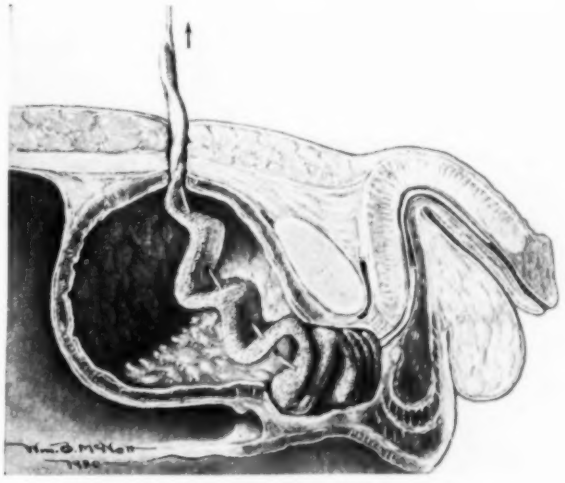

Fig. 8. Removal of prostatic pack.

factory as a hemostatic agent, while we feel that its antiseptic qualities are a distinct advantage. In our last 67 consecutive prostatectomies this pack has been used and in no instance has there been the slightest hemorrhage.

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The American Journal of Surgery is truly independent and enters into no "entangling alliances." It publishes many papers read before the leading surgical societies of the Country, but it is *not* "the official organ" of any organization. Every manuscript is selected by the editors, as worthy of publication—nothing is published merely because "it was read at the meeting."

EDITORIAL

MATERNAL MORTALITY

MORTALITY from childbirth still excites the interest of the entire civilized world. Its morbidity we can but guess at, although we know it is formidable. It is possible however to compare parturition mortality in the United States with the death rate from the same cause in other countries of the world. Although there has been much dispute over the correctness of the figures, and the justice of various conclusions which may be drawn, the United States suffers by comparison. There is no doubt about that.

In Great Britain, Mr. Arthur Grenwood, Minister of Health, is astonished to discover that although infant mortality, and the general death rate are reduced, no progress whatever is being made in the reduction of maternal mortality.

Now we are told that recent figures make us look worse, possibly the worst in the world. For this an increased incidence of puerperal infection is responsible. To say that we should pause and take stock is trite. For a long time we have been concerned, without any apparent success, in the solution of the problem.

If labor is becoming less and less a physiological phenomenon, as DeLee has so long contended, social, economic or other factors in our environment must play their part. The medical profession as a cross section of our people, have been as much affected by their environment as their patients.

While, for some years, our attention has been directed to betterment of antenatal care, and properly so, yet this has not

resulted in any appreciable improvement in the gross figures. Like the periodic health examination, even good prenatal care may be overstressed. Good obstetrics during the time of parturition is by far the most important single factor in the problem. How to procure this? The answer seems simple. Better and more nearly perfect medical education. The recent New York Hospital-Cornell Medical College Association, with its absorption of the Lying-In Hospital, and the development of a great woman's clinic modeled on the lines of the German University Frauenclinics, and backed by great funds for research, hopes to solve the problem this way. But it can not.

Only when post-graduate education of the practicing physician becomes continuous will real progress be made. Not that he must take courses in post-graduate schools. He will not. Nor are there any schools equipped to give him what he needs. Lectures, journals and reams of written advice fail to do anything more than educate specialists and the serious minded who are striving to improve themselves. The everyday doctor must be in everyday contact with good obstetrical skill and judgment. He must be able to get proper help when he needs it. He has been left to his own resources long enough. He should grow in experience and judgment, not by his own efforts, only a few can, or at the expense of his patients, but supported by consultation or help when the actual obstetrical emergency arises. Weedy, natural growth, stimulated by expediency and necessity, should respond to careful direction.

Great hospitals, particularly in urban centers of population, should not be content to stand by while puerperal mortality takes its yearly toll. Much of that is preventable. Proprietary hospitals, like a mushroom growth, have sprung up all about them. Often with little or no supervision from city or state, they steadily increase in number and influence, and admit an ever increasing number of women for delivery.

Their great neighbor usually does excellent obstetrics, *but its staff is closed.* And it should be, *but not for obstetrics.* Long the specialty of the general practitioner, the bulk of the work will probably always be done by him. Let his patients come to real hospitals for delivery by their own doctors, who as a rule will conduct themselves properly, and be bound by any protective regulation the hospital may make, such as compulsory attendence at the staff conference, or consultation when needed. Their sense of responsibility will grow keener, and the patients' troubles grow less with increasing contacts with the form and substance of good obstetrics. Hospital bed capacity must increase with the demand, but average hospital cost will decrease, and the hospital will finally fulfill one of its finest functions, and play a great part in the solution of this most important problem. Nowhere but in continuous effort to bring education to the general practitioner, will the answer ever be found.

Charles A. Gordon

DR. RUDOLPH MATAS' BIRTHDAY VOLUME

NEXT month's issue of The American Journal of Surgery will be devoted to a collection of papers written in honor of Dr. Rudolph Matas' seventieth birthday. This will make a volume of over 400 pages. The following committee has the matter in charge: Isidore Cohn, M.D., Chairman and Treasurer; C. C. Bass, M.D., Henry Bayon, M.D., Henry Daspit, M.D., E. D. Fenner, M.D., I. M. Gage, M.D., H. B. Gessner, M.D., C. J. Landfried, M.D., F. A. Larue, M.D., I. I. Lemann, M.D., R. C. Lynch, M.D., Urban Maes, M.D., Henry E. Menage, M.D., A. L. Metz, M.D., C. Jeff Miller, M.D., Alton Ochsner, M.D.

After the October issue of THE AMERICAN JOURNAL OF SURGERY has appeared these articles will be republished in book form. The edition will number 1000. Four hundred of these will be autographed by Doctor Matas and sold by the Committee at $15.00 a volume. The remainder will be offered at $10.00 a copy, by the publishers.

Many of America's leading surgeons have contributed to this volume. The names of contributors are synonymous with modern surgery. There will be contributions from the pen of J. C. Bloodgood, Robert C. Coffey, George W. Crile, John B. Deaver, J. M. T. Finney, Senior and Junior, Evarts Graham, Frederick L. Hoffman, J. Shelton Horsley, Rene Leriche of Strasbourg, Howard Lilienthal, William J. Mayo, Paul Moure of Paris, Joaquin Trias-Pujol of Barcelona, Mont R. Reid, E. Ribasy Ribas of Barcelona, Hubert A. Royster, and D. P. D. Wilkie of Edinburgh. The titles cover a wide field in the domain of surgery.

In this issue, the usual features appearing monthly in THE AMERICAN JOURNAL OF SURGERY will be omitted.

Doctor Matas, now Emeritus Professor of Surgery at Tulane School of Medicine, is one of the giants of American Surgery. His contributions to surgical technique, research, and literature have been many and important. Therefore, now that he has reached the autumn of his life, it is eminently fitting that his professional friends and colleagues make this gesture in his honor.

T. S. W.

Subscribers to The American Journal of Surgery, *visiting New York City are invited to make the office of the publishers, Paul B. Hoeber, Inc., 76 Fifth Avenue, New York, their headquarters. Mail, packages or bundles may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; kindly advise in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

MARCH 12,
1870
—
JUNE 29,
1931

JOHN OSBORN POLAK

The American Journal of Surgery
N. S. Vol. XIII, September, 1931

JOHN OSBORN POLAK

March 12, 1870—June 19, 1931

JOHN Osborn Polak died suddenly Monday morning, June 29, 1931.

When most of his staff had left the city over a sweltering week-end he remained at his desk to finish a paper that had been promised. This was characteristic, he worked year in and year out, his day starting at six in the morning and ending near midnight.

In his death America lost one of its illustrious obstetricians and gynecologists. Both specialities were enriched because of his ceaseless labors. He strove constantly to better the standards of medical education and practice. He was particularly interested in young men and throughout the country are scores of men he trained. Many of his "boys" are making solid reputations in their chosen field.

He contributed voluminously to the literature. Essentially the clinician, textbooks, monographs and journal articles bore his name as author. He religiously attended meetings of local medical societies, and meetings held throughout the country whenever it was possible for him to get away from his large practice.

High honors were bestowed upon him at home and abroad.

Doctor Polak was a member of the editorial board of The American Journal of Surgery and gave much of his valuable time to his duties. He was generous in making suggestions, offering constructive criticism, and in going out of his way to make a promise into a reality. It was his habit to do a thing well or not do it at all. The publisher and editor will miss his presence, his inspiration and kindly offices.

Conspicious in this country and abroad, simple in his tastes, temperate, considerate of others, his friends were legion. As has been said of all men of distinction, he passed on too soon. But to those who admired and held him in great affection, his name will be inscribed on the tablet reserved for "the loved and lovable whose names live evermore."

T. S. W.

"SIMS' POSITION"

JAMES MARION SIMS, one of the gynecological pioneers in America, was born in Lancaster District, South Carolina, January 25, 1813.

Sims was given the degree of Bachelor of Arts at the College of South Carolina in 1832. He started the study of medicine in the office of Dr. B. C. Jones, a practitioner of Lancaster, South Carolina. He began his first lectures at the Medical College of Charleston, South Carolina, in 1834. He graduated from Jefferson Medical College, Philadelphia, in 1835.

For eighteen years he engaged in general practice in Alabama. At a time in life when most physicians would have thought they were permanently settled he was attacked with a diarrhea. Inasmuch as this type of diarrhea was fatal to those who remained residents of the South, Sims began to wander from place to place. Having a growing family and being in want of funds he settled in New York City at Madison Avenue and 29th Street. This was in 1853. His residence was out in the "sticks" as at that time there was no first-class dwelling north of 23rd Street.

Within a short time recognition came and he was a busy man. He founded the State Hospital for Women in 1855 (New York City). In 1868 he was made Governor and Senior Consulting Surgeon of The Woman's Hospital (New York City). During the Franco-Prussian war he was Surgeon-in-Chief of the Anglo-American Ambulance Corps. Dr. Sims was president of the American Medical Association in 1876 and of The American Gynecological Society in 1880.

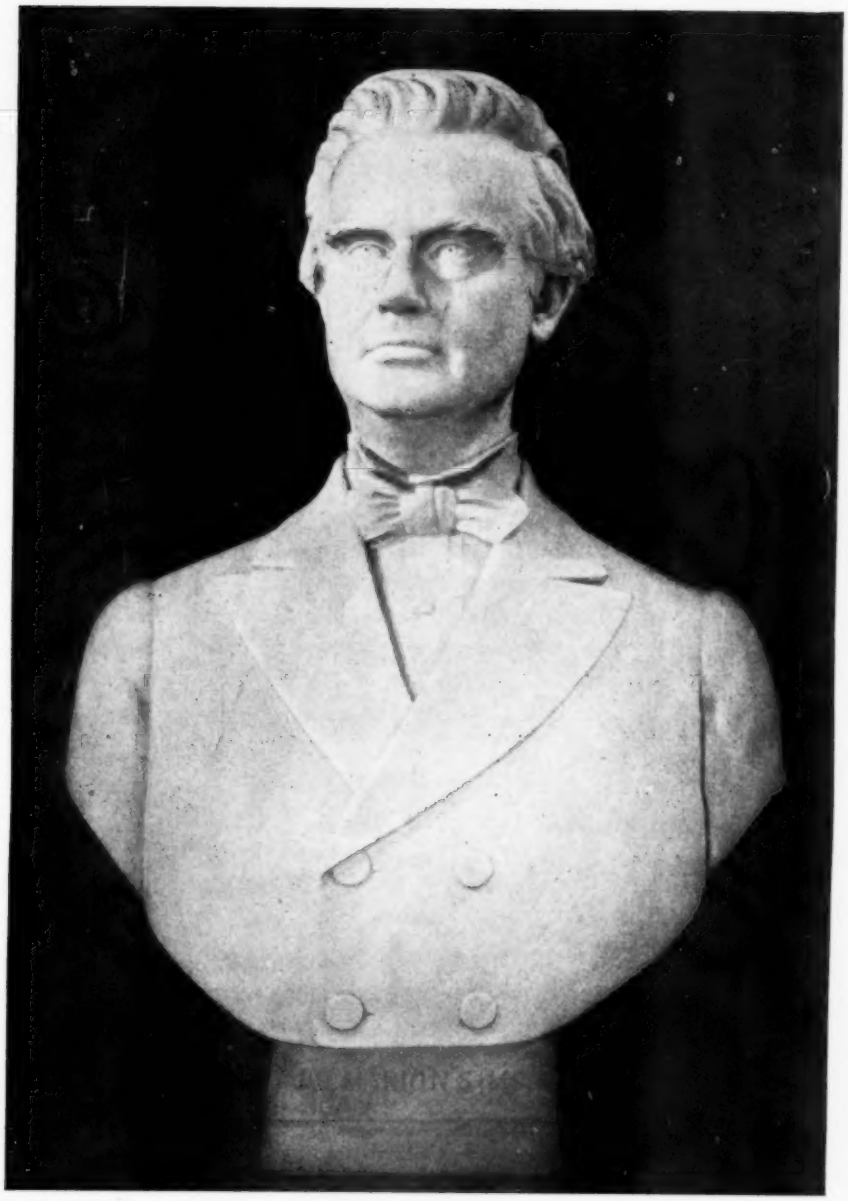
His first contribution to medical literature was an article on Trismus Nascentum which appeared in the *American Journal of Medical Sciences* in 1846. His epoch-making papers had to do with Silver Sutures in Surgery (1849) and Vesico-vaginal Fistula (1852).

His surgical treatment of vesicovaginal fistula gave him world renown. Until his technique was perfected this condition as a result of child-bearing had little chance of being cured. Sims' operation revolutionized the handling of these cases and proved a boon to womankind.

While practicing in Alabama Sims, by chance, discovered that air entered the vagina when a woman is examined in the knee-chest position. In time he changed his method of examining the woman to that of lying on her left side (Sims' position). He reserved the knee-chest position for special examinations or treatments.

Sims enjoyed one of the largest practices of his time in New York City. His first patient was referred to him by Dr. Valentine Mott. The patient had a vesicovaginal fistula. It has been written that he was "a kind hearted but impulsive man." He was one of America's most gifted surgeons and his name will be a permanent one in medical history.

He died, in his seventieth year, on November 13, 1883.



J. MARION SIMS

[1813-1883]

[From Fernelius' Universa Medicina, Geneva, 1679.]

BOOKSHELF BROWSING

SURGERY AMONG THE NORTH AMERICAN INDIANS*

ERIC STONE, M.D., F.A.C.S.

PROVIDENCE, R. I.

IF questioned about the medical practices of the American Indians most physicians would exceed their knowledge by murmuring something about bizarre ceremonies, incantations and mumbojumbo. These certainly were phases of American medicine but a study of the subject reveals a surprising amount of realistic treatment for those conditions with which the Indian was familiar. The Indians' total inability to grapple with the problem of epidemic infection, their terror and the absurdities to which they resorted created the popular opinion a hundred years ago that Indian medicine was non-existent. Only recently are archeologists and ethnologists bringing to light not only the pageantry but also the rationality of aboriginal medical practices. The picturesque ceremonies were used either as a psychotherapeutic adjunct to legitimate therapeutics or were employed in the face of grave disorders, usually those in the realm of internal medicine, where the pathological process was beyond the reach of their diagnostic powers. The Indians' crowning achievements, medically, lay in the field of surgery; especially if we consider surgery to include the care of wounds, fractures and dislocations. This is not remarkable as it was just such disturbances to which they were most subject as the chase and warfare were important elements in their life.

While the average Indian knew infinitely more anatomy than the average white man the Indian medicine-man knew much less than his European brother. But it was not the lack of anatomical knowledge which limited to a marked degree the general surgery of the Indian. Nor was it the ignorance of theories of sepsis and antisepsis for the invaders were just as ignorant. The ultimate reason for retardation of surgical development lay in the dependence of the Indian on implements provided in the natural state by their environment. All their tools for any occupation consisted of stone, shell, horn, wood, bone, reeds or grasses and animal parts. The development of surgery to an unappreciated extent was due to the development of tools, especially those with cutting edges. The keenest cutting edges the Indian could produce were those made by abrasion and grinding of flint chips. This set a definite limit to the possibilities of their surgery. This, I believe, was even more important than the absence of the inductive method of thinking.[1,18]

* Submitted for publication Aug. 10, 1931.

The Indians' material culture was that of the Stone Age, in curious contrast to their high artistic and ideational development. They lacked forceps, hemostats, indeed all essential surgical implements. However, with their crude instruments, the flint, the thorn and sinew, the cautery of glowing coals, sticks and thongs they achieved noteworthy results.

During the three centuries of contact with the invaders the Indians assimilated but little of the foreign culture, that little consisted in borrowing or stealing the white man's weapons of offence. Indeed as one reviews the relations of the two races there was little in the contact which would invite the Indian to covet or admire the other's culture. At present the European culture is being shoved down the throats of the resistant remnants; but even today in many phases of life they cling to their traditions. Although there are a relatively large number of Indians practicing orthodox medicine in the United States at present, some 600 having been graduated from recognized schools of medicine, the majority of medicine-men are practicing precisely as did their archetype of 300 years ago.

In pre-Columbian days certain tribes of the Southwest, under the influence of the advanced Mexican and Central American civilizations, practiced trephining. The indications for the operation were probably not those of today for as far as can be learned the procedure was carried out on those possessed by evil spirits and the object of the decompression was to allow these spirits to escape. But that practically the procedure was good therapeutics in some cases was not to be doubted as many persons suffering from intercranial pressure present symptoms which would have appeared to the Indians to denote demoniacal possession. The degree of bone repair found in many trephined skulls indicates that there was a relatively high survival rate. It is further known that those who survived the operation were considered sacred and became part of the priesthood. But this art had disappeared by the time of the Spanish conquests and nothing is known of the technique or of the instruments used in the operation.[13]

Perhaps the most interesting operation performed on the continent at the time of its discovery was the incision and drainage of the chest in cases of empyema. This was not infrequently carried out by the Indians of the Great Lakes area as they were peculiarly subject to lung affections. The ribs were not resected; but very decent drainage and a high percentage of cures were attained by this method of treatment at a time when it was seldom or never employed in European practice.[15]

For the rest of the more formal phases of surgery little can be said. All Indians could amputate digits; but not arms or legs. Boils and abscesses were opened, and drained by wicks of shredded bark or reeds. The indications for phlebotomy were understood and the operation was widely used.[16,13,18]

The North Carolina Indians were the only ones who understood the use of the ligature. This knowledge permitted an interesting operation which they employed on their slaves. To prevent the unfortunate prisoners' escape they mutilated their victims' feet. An incision was made along the dorsum of the foot at the base of the toes and carried back to the head of the metatarsal bones at which point amputation was completed. Bleeding vessels were tied with ligatures of sinew (an improvement over the thread or wire ligature in vogue at the time in Europe). The skin flap was rolled down over the exposed joint surfaces and restored by sinew threads to the sole. This was quite an operation especially from the point of view of the slave as the instruments consisted of scalpels of sharpened flint and needles made of thorns.[18]

A more modern instance is interesting in that it demonstrates the Indians' knowledge of hypnotics and presents surgery as it had been practiced by them through-

out the ages. In 1902 Naiuchi, a famous Zuni medicine man of the old school, opened a breast abscess. The patient

Fig. 1. Trephined skull.[11]

was given a bowl of infusion of jimson-weed (Datura stramonium) to drink and in a few minutes seemed to be in a deep and peaceful sleep. The abscess was widely incised with a fragment of flint and as the operator broke up the loculi with his unwashed and ungloved finger a large amount of pus was evacuated. Yucca wicks were placed and the wound dressed with a ground squash seed poultice. During the entire procedure the patient slept soundly, making no move, not even a grimace.[17]

In the treatment of wounds the Indians were on familiar ground and might justly be proud of their work in this field. The principles which guided them bespeak keen observation and a clear understanding of the problems involved. They understood the importance of debridement, immobilization, drainage, wound suture, the difference between healing by first intention and that after suppuration and in the presence of the latter knew the efficacy of cure by granulation in a widely open wound.[7,10,14]

The Tuscarora, Dakota and Winnebago Indians sutured larger wounds with sinew threaded on bone needles, removing the suture in from six to eight days. They insisted that their wounds should heal from the bottom, which they accomplished when using sutures by placing a thin membrane of bark between the cut surfaces before placing their stitches. Some Indians, notably the Mescalero-Apache, used twists of fiber or cloth as wicks for drainage. Most tribes contented themselves by removing only the more superficial foreign bodies or comminuted bone fragments; but the Tuscarora showed a skill in debridement and the removal of even deep seated arrowheads or shot that would have been creditable in 1918.[7,10,14]

They dressed their wounds daily and used as medicaments only those things which promoted drainage or by osmotic action caused external flow of serum and other fluids. Until the wound healed they never applied salves which tend to seal the wound. They used washes, powders, poultices and packs; a few of their applications we know actually had antiseptic properties and others were stimuli for granulating tissue.[7,10,14]

The use of nicotine was extensive, tobacco being chewed and tamped in the wound as a plug or ground and dusted into it. Nicotine is widely antiseptic and draws fluid from raw surfaces. In 1912 a friend of mine took a canoe trip with an Indian guide. One day when bathing he tore his right thigh from just above the knee to within 2 in. of Scarpa's triangle and to a depth sufficient to expose the saphenous vessels. The guide daily packed this wound with tobacco and the wound healed by first intention and in two weeks was functioning freely. A month later the wound was a fine hairline of scar.

Another widespread practice, especially in compound fractures, was an almost constant irrigation of the wound with cold

water. The New England tribes used the turpentine boiled from the wood of white pine in a similar way, or applied the bark, gum tree. Dandelion greens were ground fine and powdered on wounds and the whole leaf laid on as a top dressing. The

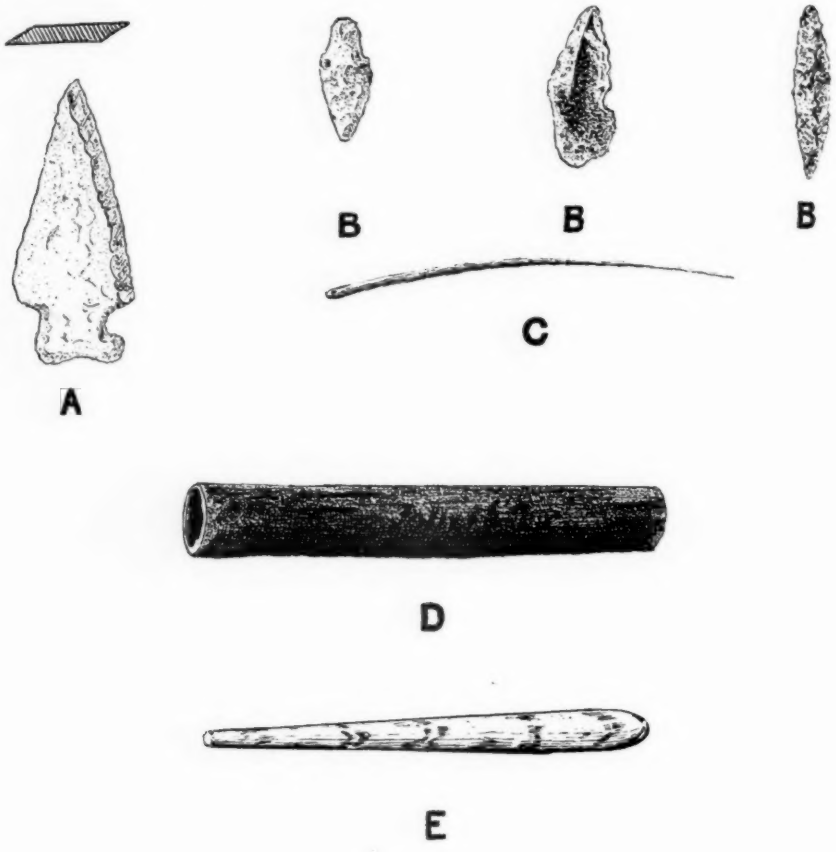


FIG. 2. A. Flint knife.[4] B. Phlebotomy flints and scarifiers.[19] C. Bone needle.[8] D. Bone tube for ritualistic sucking and blowing powders on wounds.[19] E. Tamponer of carbonate of lime.[1]

beaten to a pulp, as a poultice. They also used the bark of the alder as a poultice, and decoctions of the bark of sarsaparilla or infusions of hellebore were applied as wet dressings. Scrapings of the root of the water-lily were placed on granulating wounds to speed all regeneration. In the middle Atlantic area kerosene, which they skimmed from marshes, was used as wet dressings. In the Southwest hot poultices of crushed watermelon or squash seeds were common. The Southern Indians made wet dressings of decoctions of the root of pennywort, sometimes mixing with it an antiseptic and astringent gum obtained by boiling the root of the sweet Indians of the Great Lakes region and the Missouri River made tents or poultices of the barks of slippery elm or common elder. A growth from the bark of the wild rose was scraped off, charred and powdered on open wounds. In short the Indian not only knew what effects he desired of his treatment but had discovered what local herbs would bring about these results.[2,6,8,11]

As described previously, one tribe at least knew the use of the ligature in controlling hemorrhage in wounds. Most of the tribes understood the use of the cautery to stop bleeding and used live coals or burning brands for this purpose. For oozing the Mescalero for instance packed

the wound with eagle's down. The Haidah used spiders' webbs and the Missouri River Indians employed puff balls, all acting as effective coagulants. Where smooth sumach was indigenous its hemostatic property was well known. All tribes could apply the tourniquet.*

This sounds like relatively modern medicine and becomes even more impressive when compared with the practices of contemporaneous whites. The Indians were carrying out these rational procedures in the care of wounds even as far back as the time when European doctors were despairing of the use of the cautery and boiling oil and had swung to such extremes as the puppy fat dressings of Paré and the "weapon salve" which Paracelsus was endeavoring to repopularize.[6]

That the Indians had peculiar success with wounds is abundantly attested by a host of witnesses as all observers, medical and military, noted the beautiful results of the aborigines' methods of treatment as compared with those of the whites. Indians seemed to have recovered from injuries which would have been fatal to a white man. At a time when gunshot wounds of the bladder were invariably fatal to the pioneer these injuries were well borne by the Indians. Loskiel examined a man whose face had been torn in a fracas with a bear, the limbs lacerated, the rib cage crushed, and the abdomen disemboweled. The man had crawled four miles to his village and in six months had completely recovered, except for hideous scarring. Bourke reports the cases of two severely wounded Indians who had been discharged from a military hospital, in extremis, that they might die among their people. But a month later it was found that they had completely recovered under the care of their own medicine-men. Such records could be continued indefinitely as white men were so impressed by the ability of the Indian to survive terrific wounds that hundreds of cases have been described.[5,16]

*References 2, 7, 10, 14, 18.

The Indians were as familiar with fractures and dislocations as they were with wounds, and were just as successful in their treatment. The knowledge was not confined to the medicine-man for the lay Indian was almost as adept as his professional brother. As a result it was rare to find a deformity after a fracture.

In most tribes broken bones were immediately set and splints applied. The splints were usually made of slats, lengths of sapling or stout reeds cut long enough to immobilize neighboring joints. Near their two ends the slats were fastened to one another by running thongs in such a way that when applied they were about 2 in. apart. When such an arrangement was put in place it gave very efficient support, could be easily readjusted and gave ample space for the application of soothing lotions or poultices or for the treatment of the wounds in compound fractures.[3,12,13,18]

Some of the tribes devised very perfect splints. The Shoshone made a cast of raw hide saturated till pliable with water. This was moulded about the limb after the reduction of the fracture. When dried they resulted in a rigid cast as perfect as any now produced by plaster of Paris. The Winnebago and Dakota hit on the same device, except that they employed sheets of bark. In both types windows were cut where wounds existed.[2,6,15]

After union the limbs were skillfully massaged, exposed to the sun or treated with heated stones, and passive and active motion used to restore function.

In regard to dislocations their treatment was equally good. A few of the tribes did not understand the reduction of the hip; but all knew how to reduce dislocated shoulders or digits. The Ottawa and Chippewa realized the importance of muscular relaxation, and having noted the relaxation of the muscles in the presence of nausea, brought this on by administering emetics before attempting reduction. Loskiel happened on a lone hunter just after he had reduced a dislocation of the hip. The Indian had strapped the foot of his

injured leg to a tree and then pushed himself away from it using his arms and uninjured leg and with appropriate rotations of his pelvis had snapped the head of the femur into place.[9,16]

The really remarkable recoveries from wounds and injuries may not have been entirely due to skillful case management. The Indian may have developed biological aids through centuries of exposure to such accidents which militated against shock, hemorrhage and suppuration; just as the civilized man had developed a relative racial immunity to many infectious diseases. One immediately thinks of the possibilities of more effective adrenal activity or some such other endocrine adaptation. Furthermore each patient was treated separately in his own lodge or tepee and so was not subject to hospital gangrene which in the 18th and 19th centuries wrought so much havoc among the soldiers who were being wounded in the same way, at the same time.

But given these advantages on the one hand and the limitation of his physical equipment on the other, it must be conceded that the American, even at the time of his discovery, had brought certain phases of the art of surgery to a remarkable degree of perfection.

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BOOK REVIEWS

DEEP X-RAY THERAPY IN MALIGNANT DISEASE. By Walter M. Levitt, M.B., D.M.R.E., Medical Officer in Charge of the Radiotherapeutic Research Department. Being a report of an investigation carried out from 1924 to 1929 under the direction of the St. Bartholomew's Hospital Research Committee. London, John Murray, 1931.

For nearly a third of a century physicians have been treating malignant disease by means of the *x*-rays, alone or in conjunction with radium, surgery and other measures. Owing to the constant revision of ideas of dosage and penetration of rays, up to date (with perhaps a few exceptions) we have not had available the results of any definite group of patients treated by modern *x*-ray therapy alone and followed through under adequate expert supervision from both the clinical and the technical standpoint. Such a group study under ideal conditions has been presented in the report of an investigation carried on from 1924 to 1929 under the direction of the St. Bartholomew's Hospital Research Committee, the deep *x*-ray therapy having been given in the Radiotherapeutic Research Department of this hospital under the supervision of Mr. W. M. Levitt.

The techniques employed have been discussed in some detail; also the experimental and theoretical considerations from which these techniques have been built up. In recording the results the author has very carefully brought to light the debit side of the account as well as the good results; and he has made an estimate of the discomforts and the dangers associated with the treatment. Very few accidents have occurred.

The cases treated were limited to malignant disease, as follows: (1) breast, (2) uterus, (3) upper air passages, (4) esophagus, (5) rectum, (6) thyroid gland. The term "malignant disease" was defined to include any new growth which was proved on microscopical examination to be a malignant tumor, even though the type of the malignant disease could not be classified into any of the known groups. Microscopical examination was carried out in all cases, with the exception of a few where such a removal would be considered unjustifiable, as, for example, in advanced carcinoma of the esophagus. In only 30 of the 327 cases treated was there failure to obtain a biopsy. Radiographic studies of the lungs and mediastinum were carried out in all cases of carcinoma of the breast or upper air passages with enlarged supraclavicular glands, in all cases of carcinoma of the esophagus and in all cases of sarcoma in whatever situation. The one case of chorioepithelioma also underwent these radiographic studies.

The apparatus employed delivered a pulsating secondary current with a peak voltage corresponding to 42 cm., or about 230,000 volts. Changes were made in the apparatus later, so that it delivered 4 ma. of a practically constant high tension current at a parallel spark gap of 38 cm., later increased to 196,000 volts. The filtration was 0.5 mm. of zinc until July, 1926, after which time it was increased to 1.5 mm. of copper. This latter filter was chosen as being the heaviest which could be used without prolonging the duration of the exposure to a degree which was excessive from the point of view of the comfort of the patient. Owing to the comparatively satisfactory results obtained in the upper air passages and uterus groups with the heavy filter, this filter was retained for these cases from its adoption to the end of the research. In the breast and rectum groups a return was made to the lower filtration, that is, to 0.5 mm. of zinc. The highly radiosensitive small round-celled sarcomata, in whatever group, were invariably treated with the lower filtration.

The book goes into great detail in regard to apparatus and treatment and the management of the case during and after treatment. The results are discussed group by group.

There were 4 cases of the 327 treated in which death could have been attributed to the *x*-ray treatment: (1) A case of melanotic sarcoma of the vulva, where a condition resembling acute cellulitis appeared in the region which had been irradiated by the intensive single dose method, and gradually extended very widely, the patient dying of profound toxemia eleven days after treatment. (2) A case of carcinoma of the thyroid gland where the growth had fungated into the trachea. The patient died of respiratory obstruction about a fortnight after treatment. (3) A patient with a post-cricoid growth

was reported to have died suddenly at home about a fortnight after the treatment. No details were obtained. (4) A patient treated for an extrinsic carcinoma of the larynx developed erysipelas of the scrotum from which he died. It is quite possible that the disturbance of the blood picture and especially of the leucocyte elements may have contributed to the fatal result. Thus, in 3 of the 4 cases, or in less than 1 per cent of the total number of cases treated, death may have been due to a direct *x*-ray injury; and in these three the connection is neither very clear nor convincing.

There were no cases of electrical shock, either to the patients or to the personnel. Aside from the case of melanotic sarcoma already referred to, there was only one case in which a serious *x*-ray burn was produced. This was a case of carcinoma of the breast, in which following a full dose of *x*-ray, radium was applied also with full dosage. In some cases the erythema reactions produced were rather more intense than anticipated, and in a few cases desiccation resulted. In all of these, however, healing was complete within two or three weeks after the appearance of the erythema.

Tracheotomy was performed as a preliminary treatment in all cases of malignancy in the upper air passage group in which the glottis was sufficiently narrow to render the reactionary swelling dangerous. In only one case, however, was the tracheotomy necessary as an emergency method.

In the uterus group there were a few cases of irritation of the bladder and the lower bowel with diarrhea. In no case, however, was severe cystitis or proctitis observed.

Up to the present there have been no cases of late necrosis. In certain instances in the upper air passages group a perichondritis of the laryngeal cartilages was noted after an interval of several months. In one case an acute perichondritis occurred without warning—after complete freedom of eighteen months from all evidences of laryngeal disease. This patient recovered. The mode of action is probably by interference with the nutrition of the laryngeal cartilages in such a way as to render them more liable to the occurrence of bacterial inflammation. The recognition of perichondritis as an *x*-ray effect is important, since the condition is likely to be mistaken for recurrence of the growth and further *x*-ray treatment given.

In the section dealing with results, it was seen that of 319 cases included in the statistics, 48, or 15 per cent, are now without evidence of the disease. There are, however, 271 patients who have either died of the disease or are alive with signs of the disease present. In 93 of these 271 cases no appreciable improvement followed. Therefore, in about 29 per cent of all cases it may be said that the *x*-rays proved of no value whatever. In the remaining 178 cases of the group of 271, the treatment resulted in varying degrees of palliation. In 24 per cent of the total group, the patients were improved sufficiently to return to ordinary work for a time. In 10 per cent of the total group, or 31 cases, there was a lesser degree of improvement, but there was marked relief of the prominent symptom or symptoms. In 22 per cent, or 69 cases, only minor degrees of improvement were observed, lasting a few weeks only. In the patients who were sufficiently improved to be able to resume their ordinary avocations, improvement varied in duration from a few months to over three years, averaging about one year.

The net result of all the treatments, therefore, in this group was that of 319 cases included in the statistics, out of a total of 327 cases treated, 48 are free from evidence of growth at present; 109 showed a marked degree of palliation; 69 showed lesser degree of palliation, and 93 showed no appreciable improvement following the treatment.

At the conclusion of the work the author, speaking for himself and for the very dependable members of his consultant committee, felt that the following statements were justifiable:

"(1). Malignant growths, even when at an advanced stage, may be made to disappear by *x*-ray treatment, and the patients may remain free from all evidences of the disease for long periods—upwards of four years, and perhaps permanently.

"(2). The proportion of cases in which these results may be obtained varies in different situations of the disease, being greater in the upper air passages, uterus and breast groups, than in the rectum and esophagus groups.

"(3). In a large proportion of cases in which complete disappearance of the disease is not effected, marked reduction in the size of the growths and great or even complete alleviation of symptoms lasting from months to years may result. Many of these patients are enabled to return to their ordinary work during the greater part of this period.

"(4). The risks involved in the treatment are very small, and the discomfort to the patient almost negligible.

"(5). In certain cases a combination of *x*-ray with radium is probably superior to the use of either of these methods of treatment alone."

James T. Case.

The Infant Welfare Movement in the Eighteenth Century. By Ernest Caulfield, M.S., M.D. With a Foreword by George F. Still. N. Y., Paul B. Hoeber, Inc., 1931, 223 pp.

The history of pediatrics so long neglected seems at last to be coming into its own and there is now a growing list of books on the subject but as yet not long enough to prevent a new one from being an event for those interested. The latest addition is a truly charming series of essays on the welfare movement in the eighteenth century, that interesting period which saw so many beginnings grow out of its healthy scepticism. Almost everyone thinks that infant welfare is a new thing when it really goes back into the dim past and in the eighteenth century there was a remarkable impetus given to it by the deplorable conditions that obtained at that time until one wonders in reading about it if these people were really civilized after all.

Caufield's book naturally centers about the big four of the eighteenth century movement in England: Thomas Coram, William Cadogan, Jonas Hanway and George Armstrong. All giants and very human and interesting giants. By his magic touch the author has resurrected them and made them and their age live again for us. It is a book which ought to be on the shelves of everyone interested in the history of medicine.

Thomson and Miles' Manual of Surgery. By Alexander Miles, M.D., LL.D., F.R.C.S. and D. P. D. Wilkie, M.D., F.R.C.S. Humphrey Milford, Oxford Univ. Press, 1931, Ed. 8, Vol. 1, 574 pp.

A new edition of "Thomson and Miles" is always welcome. Dr. D. P. D. Wilkie has succeeded Dr. Thomson as co-author with Dr. Miles.

The first volume has been brought up-to-date by these two authors in a very satisfactory manner. The handy size of this volume (7½ × 5) is to be heartily recommended in these days of limited shelf room. So much knowledge has been crowded into 600 small pages that one readily forgives the lack of quality in the illustrations which are not quite on a par with those in other (and more expensive) volumes.

Proctoscopic Examination and the Treatment of Hemorrhoids and Anal Pruritus. By Louis A. Buie, M.D., F.A.C.S. Phila., W. B. Saunders Co., 1931, 178 pp.

A practical book on the treatment of hemorrhoids from an authoritative source has long been lacking and this book covers the subject in exactly the manner the general practitioner needs.

Dr. Buie has covered the ground thoroughly and completely and the simplified illustrations leave nothing to be desired.

The reviewer is thoroughly in accord with Dr. William J. Mayo who says in his foreword: "There is need for better work in proctology, by the surgeon, the internist and the general practitioner. Of these three members of the profession, the general practitioner stands in the position to do the most good. The time when he first sees the patient is the most favorable time to avert lurking tragedy by accurate diagnosis and opportune treatment. This little book is offered as a manual of consulting-room diagnosis of diseases of the anus and rectum and of the treatment of hemorrhoids. It is practical and sound."

Injuries and Sport, A General Guide for the Practitioner. By C. B. Heald, M.D., M.R.C.P. Humphrey Milford, Oxford Univ. Press, 1931, 543 pp.

A special book on the injuries received in sport might seem at first to be unnecessary. Even an occasional glance at the contents, however, will show that there is a very definite place in the library of every physician for a book of this kind. It tells concisely what to do and how to do it so that it may be referred to in times of emergency. Medical men in colleges and schools and those at summer resorts will find this book particularly valuable.

Collected Papers of the Mayo Clinic and the Mayo Foundation for 1930. Vol. XXII. Edited by Mrs. Maud H. Mellish-Wilson, Richard M. Hewitt, M.D., and

Mildred A. Felker, B.S. Phila., W. B. Saunders Co., 1931, 1125 pp.

The famous Mayo papers reached their maturity with the publication of the twenty-first volume last year. Volume XXII, now before us, is an indication that this series is entering upon its adult years, full of strength and ambition, and gives every evidence of continuing the healthy virility of its youthful years.

The remarkable range of activities of this outstanding clinic is nowhere better symbolized than in this annual volume.

Of the 482 papers emanating from this clinic in 1930, 85 are reprinted in full, 30 are abridged, 55 are abstracted and of 312 only the titles are given. Despite this careful editing, we have a volume of over eleven hundred pages. It would be interesting to have all the Mayo papers printed in book form and indexed. No doubt, they would form the best possible record of the progress of surgery at this time.

BREAST-FEEDING. By Margaret Emslie, M.B., CH.B. London, Humphrey Milford, Oxford Univ. Press, 1931, 142 pp.

As the author says in her Preface, "Breast-feeding is a function of which there should be little to learn in the year 1931, yet never probably has breast-feeding given so little cause for satisfaction as in this time." Dr. Emslie has covered the subject in a concise fashion and for the pediatrician this book will be a handy work of reference.

THE PAPYRUS EBERS. Translated from the German version by Cyril P. Bryan, M.B., B.CH., B.A.O. With an introduction by Prof. G. Elliot Smith. N. Y., D. Appleton & Co., 1931, 167 pp.

Prof. G. Elliot Smith states in his Introduction: "The Papyrus, although written about 1500 B.C., is really a collection of bits and pieces of folk-lore, much of it five and some of it probably twenty centuries older. It is expressed in archaic phraseology, so that many of the terms relating to the diseases and drugs are impossible to identify. In the face of these insuperable difficulties, it is not surprising that most scholars have refrained from risking their reputation for scholarship by pretending to translate a technical document in which many of the technical terms are at present untranslatable.

"An heroic attempt to provide a translation in German was made, however, many years ago by Dr. H. Joachim. This attempt naturally provoked many criticisms, especially from those scholars who had the philological knowledge to recognize the solecisms. But if the time is not yet ripe for an adequate translation, the Papyrus is so interesting that no excuse should be necessary for providing a rendering in English of the only version at present available for those who cannot read the scripts of Ancient Egypt. Hence Dr. Cyril Bryan is to be commended for giving us in English an interpretation based upon Dr. Joachim's translation, though not slavishly following it."

Both Dr. Bryan and the publishers are to be congratulated upon making this book available to English-speaking readers. It makes a splendid companion to the more ambitious translation of the Edwin Smith Papyrus recently published in this country.

DIAGNOSIS IN JOINT DISEASE, A CLINICAL AND PATHOLOGICAL STUDY OF ARTHRITIS. By Nathaniel Allison, M.D., F.A.C.S. and Ralph K. Ghormley, M.D. N. Y., William Wood & Co., 1931, 196 pp.

The authors have devoted six years to what they term the "complete study" of arthritis. In this time, they have obtained records in 289 cases, concerning themselves chiefly with a systematic presentation of the clinical facts and pathological variations of the cases. The authors have attempted to point out methods of diagnosis and classification that will simplify the process for the average medical man.

Beautifully produced and illustrated, it is unfortunate to see the title page marred by two misprints.

PRACTICAL X-RAY TREATMENT. By Arthur W. Erskine, M.D. Saint Paul, Bruce Publishing Co., 1931, 112 pp.

In less than 120 pages the author has set down those methods of treatment which he has used himself, expressing in each instance his reasons for selecting them. No attempt has been made to include all the methods used. This work, therefore, is a splendid starting point for the beginner in roentgen therapy and offers great advantage over the larger works which often confuse rather than assist a beginner. On the other hand, after studying this book the reader will be well prepared to seek further details in other volumes.

PRINCIPLES OF PREOPERATIVE & POSTOPERATIVE TREATMENT

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PUBLISHED SERIALLY IN

The American Journal of Surgery

NINTH INSTALLMENT

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PRINCIPLES OF PREOPERATIVE & POSTOPERATIVE TREATMENT

Chapter XIV

THROMBOPHLEBITIS

Postoperative thrombophlebitis occurs as one of the late complications of operative procedures. It makes its presence known usually during the second or early third postoperative week.

According to many observers the development of the condition is insidious in that close observation during the earlier period of convalescence will frequently reveal an elevated pulse rate (Mahler[1]), an elevated temperature (Michaelis[2,3] Petrén,[4] Hampton and Wharton,[5] or both an elevated pulse rate and an elevated temperature, the source of which is not evident at the time.

1. Incidence

Thrombophlebitis is found as a complication of all types of operations, and the development of sepsis in wounds does not seem to act as a predisposing cause; most cases seem to develop in connection with so-called "clean" surgical procedures. Postoperative thrombophlebitis may occur in any vein in the body and after operations even so slight as the extraction of a tooth, the removal of a cataract, the removal of tonsils, or the performance of submucous resection of the septum nasi.

The frequency of occurrence of thrombophlebitis following abdominal operations has been variously estimated at between 1 and 4 per cent, the majority of observers favoring a lower rather than a higher figure within these limits, and almost all being agreed that this complication follows pelvic surgery more frequently than surgery of the upper portion of the abdomen.

Beckman[6] reported 16 cases in 5835 operations performed at the Mayo Clinic. Clark[7] found 35 cases in 3000 operations. Hampton and Wharton[5] reported 205 cases in 21,000 gynecological operations performed in the Johns Hopkins Hospital Clinic. Klein[8] found 70 cases in 5851 operations, Bondy[9] 13 cases in 1000 gynecological operations, Ranzi[10] 1.2 per cent of cases in a series of 6071 operations.

As previously stated, any vein in the body may be the seat of postoperative thrombophlebitis. When, however, the process involves the deeper veins the diagnosis is usually difficult and indeed often impossible during life, whereas, conversely, the more superficial the veins involved in the process the more readily is the condition recognized. For this reason thrombophlebitis of the femoral and saphenous veins can frequently be diagnosed in the recent state, but cavernous sinus thrombosis and thrombosis of other deep veins and blood sinuses though possibly not suspected during life may not infrequently be found post mortem if specifically sought. Since thrombophlebitis of the lower extremitis is, therefore, the variety commonly diagnosed and also, as a matter of fact, the only type for which methods of treatment have been devised, the present discussion is perforce concerned almost exclusively with thrombophlebitis of the lower extremities.

II. Etiology

Presumably at least two general factors are concerned in the production of thrombophlebitis: (1) injury to the endothelial lining of the blood vessels, and (2) retardation of the flow of blood through the lumen of the vessels. The exact manner in which these two changes are produced is largely a matter of debate at the present time.

In spite of much speculation on the subject little of actual importance has been added to, or subtracted from, the original conception of Aschoff.[11] He considers that the fundamental process is slowing and eddying of the blood in the veins of the thigh, particularly in the upper part of the femoral

vein and the pelvic plexus. As a result of this action blood platelets are sifted out of the blood stream and are deposited on the walls of the veins particularly in the region of the valves. As they collect some interaction occurs between the platelets and the intima of the blood vessel whereby they become adherent, the one to the other, and initiate the formation of a white clot. As the coagulum increases in size it tends to block the lumen of the vessel more and more completely; ultimately flow of blood through the vessel ceases, and red blood clot forms until it obliterates the vein progressively to the point of entrance of the next afferent tributary.

For a most complete and thorough consideration of the various physiological, biochemical, and theoretical considerations of the subject the reader is referred to the monograph presented by Ritter before the International Society of Surgery, Warsaw, July, 1929.

Certain investigators have suggested sepsis as an important factor, interpreting the relatively considerable period of time between the performance of an operation and the development of symptoms of thrombophlebitis as the incubation period of the infectious organism, but there is little evidence to support such a view. Lubarsch studied 215 cases of thrombophlebitis bacteriologically and was able to demonstrate organisms in but 20 instances.[12]

Possibly the source of the trauma to the walls of the vessels may be different in different cases, sometimes (a) mechanical, sometimes (b) toxic, and sometimes (c) bacterial.

Most clinicians believe that the enforcement of a prolonged period of recumbency in bed predisposes to the development of the condition by generalized or localized slowing of the circulation. Such a theory is thought to elucidate the mechanism of occurrence of thrombophlebitis in the lower limbs especially, and also to account in some part at least for the interesting clinical fact that thrombophlebitis of the left leg is of the order of nine times as frequent as thrombophlebitis of the right leg.

Localized slowing of the circulation in the lower extremities is supposed to be produced as follows:

1. Poupart's ligament compresses the femoral vein against the horizontal ramus of the pubic bone.
2. From this point to the inferior vena cava venous blood has to flow against gravity.
3. The right common iliac artery (or occasionally the abdominal aorta) compresses the left common iliac vein against the spine.
4. The sigmoid flexure of the colon, which often is filled with inspissated fecal material, is more apt to interfere with the circulation in the left common iliac vein than with that of the right common iliac vein.

Bachman and Bizzaro[13] believe that thrombophlebitis may be anticipated as a complication in all conditions in which the number of platelets per cubic millimeter of blood is much increased. These authors regard 750,000 platelets per cubic millimeter as the upper limit beyond which such a complication may be expected to occur. Thrombophlebitis occurs with a fair degree of frequency in many non-surgical conditions, chlorosis, gout, influenza, rheumatism, pneumonia, typhoid, and typhus. Presumably the mechanism of production is not dissimilar in the surgical and non-surgical cases.

Chauvin, Esmenard, and Jaur[14] have shown in a series of 25 cases that there is usually a slight but insignificant increase in the coagulation time following operative procedures and that gynecological operations, which are more prone to be followed by phlebitis than other varieties, show this particularly; the blood coagulation time, however, in 8 cases in which phlebitis had already developed, showed slightly shortened but constant coagulation time.

Various other factors proposed as predisposing causes of thrombophlebitis are:

1. Heart derangements (Albunus[15])
2. Pressure of tumors on veins (Albunus[15])
3. Handling of blood vessels while the abdomen is open (Albunus[15])
4. The effect of narcosis on the heart (Albunus[15])
5. Bandage pressure (Albunus[15])
6. Rough handling of retractors (Clark[7])

7. Necrosis in stumps distal to ligatures (McLean[16])
8. Transfixion of vascular areas by ligature (McCann[17])
9. Varicose veins (Bartlett[18])

III. Symptomatology

Subjectively patients developing postoperative thrombophlebitis usually complain of localized deep soreness which is present during rest but is aggravated during motion and is described as a dull, burning ache. In some cases there is actual acute pain, which in exceptional instances may be severe enough to require the use of morphine for its relief. The most important single sign of the condition is tenderness along the course of the affected veins, and the diagnosis may not be made in the absence of this (Fig. 55).

Edema is important when present; it occurs in about 50 per cent of cases. In the case of post-partem thrombophlebitis of the lower extremity Homans[19] believes that the white swelling which often develops and which he very aptly describes as "porky" edema results from interference with the lymphatic drainage of the part. Such an occurrence should not be surprising, considering the intimate association between the deep veins and the lymph vessels, the latter occasionally being actually embedded in the adventitia of the walls of the veins. This intimate relationship is particularly seen in the groin and along the iliac veins, since in this area the entire lymph drainage of the lower extremity courses in very close proximity to the large veins. An inflammatory reaction in the veins could hardly fail to produce a similar reaction in the lymphatics. In cases which do not present edema presumably the superficial vessels alone are involved (i.e., usually the short and long saphenous veins), the presence of adequate collateral venous circulation preventing venous stasis, and the lymphatics, which course for the most part deep to these vessels, not being involved.

Systemic reactions are noted in nearly nine-tenths of the cases; the temperature characteristically rises to 100.5F. or so within twenty-four hours after the onset of the pain; the pulse

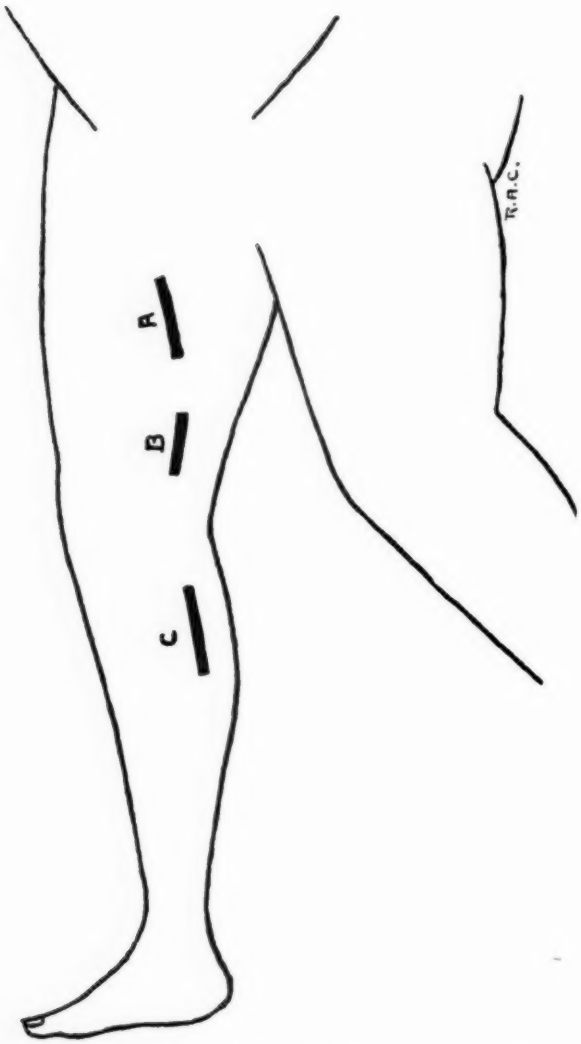

FIG. 55. Characteristic distribution of points of tenderness, in 87 clinical cases of postoperative thrombophlebitis of the lower extremity according to Brown.[1] The region of the calf of the leg designated as "C" showed tenderness in 64 per cent of the cases. In 9 per cent of the cases all three regions, "A," "B," and "C" showed tenderness. In 27 per cent of the cases tenderness was confined to the regions indicated by "A" and "B." Left leg was involved in 64 per cent of cases, right leg in 16 per cent of cases, and both legs in 20 per cent of cases.

[1] Brown, G. E. Postoperative phlebitis. *Arch. Surg.*, 15: 245, 1927.

rate in most cases does not exceed 100 beats to the minute. The duration of the systemic reaction averages 3.5 days in cases uncomplicated by pulmonary infarction, in which latter case, however, it may last as long as three weeks or occasionally even much longer.

Cyanosis of the affected part and localized redness do not ordinarily form a part of the clinical picture, though these signs may occasionally appear. It must be appreciated also that thrombosis of even a large superficial vein may occasionally produce no local signs or symptoms whatever.

IV. Treatment

The prophylactic treatment of this complication, so far as prophylactic treatment can be outlined in the absence of a better understanding of the fundamental pathology concerned, centers mainly about the prevention of stagnation of blood in the lower extremities. It has been suggested that all postoperative patients, insofar as practicable, be kept in a moderate Trendelenburg position during their postoperative stay in bed and that in the later convalescent period either passive massage of the lower limbs or active movements, as recommended by Pool,[20] in the manner of "bicycle riding" exercises be instituted.

Nurses and attendants should, however, be warned of the danger of massaging or otherwise manipulating "sore" or "painful" legs developing in postoperative cases, except in accordance with specific instructions from competent medical attendants.

In 1927 Walters[21] suggested the use of thyroid extract as a prophylactic measure against the development of postoperative thrombosis and embolism. It was argued that the judicious use of this therapeutic agent by increasing the metabolic rate should increase peristalsis, the depth of respiratory movements, and the general rate of flow of blood through the veins. The dose advocated was two grains administered thrice daily

by mouth, beginning on the third or fourth postoperative day and continuing for seven days or until the patient was sufficiently convalescent to be allowed out of bed. In a series of 1745 cases subjected to major surgical procedures at the Mayo Clinic, Walters adopted the regime and no patient less than seventy years of age died as a result of pulmonary embolism. There were however, 2 patients, both over seventy years of age, in whom unsuspected and coincidental pulmonary embolism was found at autopsy, the patient having died of other causes.

Freund,[22] in Germany, obtained results comparable with those of Walters. In a series of 2000 cases of patients over thirty-five years of age, which had been subjected to laparotomy, prostatectomy, or hernioplasty, and had been treated postoperatively with thyroid extract, only 2 cases of fatal embolism occurred.

This proposed use of thyroid extract, though apparently so far successful in a relatively considerable number of cases at the Mayo Clinic and also in Germany, needs to be subjected to more extensive trial, especially by surgeons in other localities and under all variations of surgical practice before its true value can be accurately determined, and it should be especially remarked that the ultimate standard by which its efficacy must be judged is its ability to prevent not only fatal embolism but also nonfatal thrombophlebitis and thrombotic infarcts. In this connection it cannot be too strongly emphasized that in surgical practice cases of embolism frequently occur in groups. A relatively long interval of time may elapse during which no cases occur, and suddenly, for no apparent reason 2 or more cases may be seen in rather rapid succession, whereupon another relatively long period of freedom from embolism occurs.

There is danger of falsely ascribing prophylactic value to any measure which might be applied during a period in which no case of thrombosis or embolism would naturally occur. Thus Popper saw 4 cases of fatal pulmonary embolism in

January 1929, no other cases for six months, and then 2 more fatal cases during the last week in July 1929. Any prophylactic measure which might have been applied during the six months from the last of January to the last week of July in Popper's clinic might have been given credit for a favorable result for which it would have deserved no credit at all.

Although the rationale of Walters' use of thyroid extract seems well founded and certainly any attempt to attack the problem of the prophylaxis of postoperative thrombosis and embolism is very welcome in view of the well-nigh helpless position with respect to this complication in which the surgeon has found himself hitherto, some evidence has already been presented which should serve as a warning to the overzealous therapeutic enthusiast.

In the first place, a carefully controlled investigation by Popper[23] has apparently failed to substantiate the value of both synthetic and natural thyroxin in the prophylaxis of thrombophlebitis and its complications. In the first series of cases there were 150 control cases and 150 cases treated by the oral administration of synthetic thyroxin. In the 150 treated cases there occurred 1 fatal case of pulmonary embolism, 1 case of thrombophlebitis complicated by infarcts, and 2 cases of bilateral thrombophlebitis. In the control series occurred no cases of fatal embolism, no cases of infarction, but 4 cases of thrombophlebitis. Because Popper suspected that the synthetic thyroxin used in this series might be less efficacious than natural thyroxin derived from animals, he used a "natural" preparation "thyropurin" in a second series of cases. In this series there were 50 control cases and 50 cases subjected to "thyropurin" therapy. In the control cases there developed 1 fatal case of pulmonary embolism associated with symptomless thrombosis of the right femoral vein and 1 case of thrombophlebitis of the right leg. In the treated cases there occurred 1 case of bilateral thrombophlebitis of the legs and 1 case of thrombophlebitis of the left leg in a patient "who made an unexpected recovery." The doses used in the two series of

experiments were synthetic thyroxin, 1 mg. thrice daily, and "thyropurin," 1 mg. (2 tablets), thrice daily. Both preparations were given orally.

In the second place, the routine administration of any drug as potent as thyroid extract is generally speaking a highly undesirable procedure. Therefore, one wonders whether the end quite justifies the means in connection with thrombophlebitis. The incidence of postoperative thrombophlebitis is, as previously noted, relatively low, and the percentage of patients who die of embolism following thrombophlebitis is much lower still. Nevertheless, in order to save the very occasional case it is proposed to subject the entire postoperative group to the action of a drug which is very potent and which is capable of causing untoward symptoms in certain cases and possibly permanent organic damage in some. As a matter of fact not all patients submitted to major operative procedures can take the recommended doses of thyroid extract at all. The most skillful surgeon can doubtless recognize many such cases at the start and in all cases will be on the alert to discontinue the medication if indications arise after the administration of the drug has been undertaken, but there is certainly a danger that the less skillful surgeon may not be in so favorable a position to do this and therein lies what seems to be a real danger which should not be lightly dismissed.

Popper found that synthetic thyroxin caused no untoward symptoms at all but concluded that it was also of no value. "Thyropurin," on the other hand, caused tachycardia, severe cardiac arrhythmia, or motor restlessness in 12 per cent of the cases.

The conservative treatment of thrombophlebitis consists in wrapping the involved part carefully in cotton wool to relieve pain and to avoid the dislodgment of parts of the thrombus as emboli into the circulation and in elevation of the part. The local application of cold over the involved area, as by the use of ice-bags, is grateful to the patient, but may be harmful in that it tends to produce local vasoconstriction, a

process at variance with the presumably beneficent vasodilatation provided by nature in the presence of inflammation. It is believed that the use of heat is much more rational, and

FIG. 56.

FIGS. 56, 57, 58, 59, and 60. The various steps in the application of an Unna's paste boot. The paste itself is composed of four parts each of zinc oxide and sheet or flake gelatin, and ten parts each of glycerin and water. The gelatin and water are placed in the inner compartment of a double boiler and allowed to stand over night; in the morning the mixture is heated over the water bath formed by the outer compartment of the double boiler; as soon as the gelatin has become thoroughly liquefied the glycerin is added and the zinc oxide is stirred into the mixture very gradually. The finished paste is of the consistency of thick cream or thin batter when hot, but sets into a tough rubbery or elastic mass on cooling. If too thick a small amount of water may be added to the paste before use; the paste may be liquefied and allowed to set a number of times if for any reason the entire amount initially prepared is not used at the first sitting.

FIG. 56. Method of elevating limb for relief of blood stasis and edema preparatory to application of boot. Limb is maintained in elevated position for at least five minutes.

heat is often quite as welcome to the patient as cold. From a practical point of view application of heat may perhaps best be effected by the erection of a light-tent or heat-tent over the affected part. The cotton wool wrappings previously applied should be voluminous in order to provide mild immobiliza-

tion of the diseased member, and since this type of dressing tends in itself to prevent heat dissipation a very considerable degree of heat can easily be maintained by the method outlined.

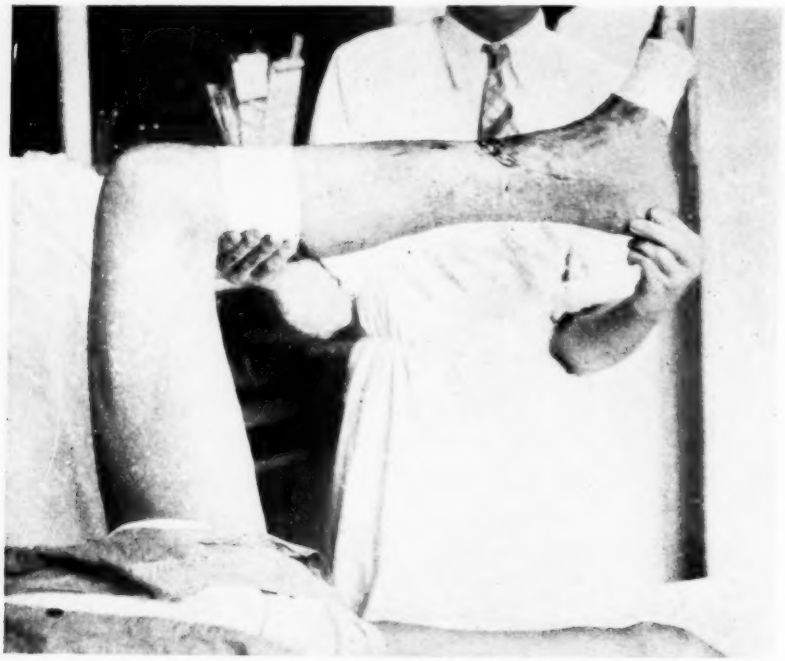

FIG. 57. Position of limb during application of boot. Thigh is flexed on abdomen to a right angle, leg is flexed on thigh to a right angle, and foot is dorsiflexed on the leg to a right angle or even somewhat more than a right angle. This position is of the utmost importance in the application of a snugly fitting, comfortable, and efficient boot. Note that the first step in actual application of boot has been taken, a couple of layers of loose meshed gauze bandage have been rolled at the base of the toes and just below the knee.

In the cases unaccompanied by much fever and local tenderness mild active exercises of the leg may be begun within a week or ten days after the inflammatory process has begun to show improvement, since in such cases the clot is presumably not very friable and, accordingly, there may be anticipated little danger from embolism. On the other hand, in those cases in which the inflammatory reaction has been more intense the infection has presumably produced a more friable clot, and elevation of the part should be continued until there is no longer generalized fever or localized tenderness.

With regard to the operative treatment of thrombophlebitis it is probably best to treat the deep iliac variety conservatively, providing the patient is not clearly suffering from

FIG. 58. Unna's paste is being painted on the leg and foot with ordinary paint brushes; note the inner compartment of double boiler from which the paste is being taken. Note also that paste is not being applied over edges of gauze at base of toes and bend of knee, but stops at some distance from these edges.

septicemia and repeated pulmonary infarction. In such cases an attempt should be made to tie the iliac vein or even the inferior vena cava central to the thrombotic process.

In thrombosis of the superficial veins of the leg ligation of the saphenous system above a process of septic thrombosis is rational, and probably indicated, provided a streptococcal cellulitis of the part be not threatening.

On getting up from bed patients should keep the affected limb in an elevated position most of the time for several days, but gradually the length of periods of dependence of the part may be increased in accordance with the swelling ensuing thereupon.

A complicating pulmonary infarction can be diagnosed in about 33 per cent of cases of thrombophlebitis, the fever continuing in these cases for an average of five days, but is only

FIG. 59. Alternate layers of loose meshed gauze roller bandage and Unna's paste are being applied to build the boot up to the desired thickness. Note that the roller bandage is cut straight across at those places in which reversed turns would otherwise be required; this is done in order to keep the boot quite smooth and comfortable. The boot completely covers the heel.

slightly higher than in other cases; usually the signs and symptoms of infarction follow the onset of phlebitis by about four days.

Hampton and Wharton[5] report the incidence of pulmonary infarction in their series at 7 per cent; 1.5 per cent developed pulmonary embolism. Patients, who in the convalescent period exhibit marked edema of the extremities, when allowed to be up and about after complicating thrombophlebitis, often may be made comfortable and a valuable therapeutic measure may be invoked by the application of a well-fitted Unna's paste boot to the part (Fig. 60). The boot is made by applying alternate

layers of Unna's paste and loose-meshed roller bandage over the affected limb from the base of the toes to just below the knee. The Unna's paste is applied by means of an ordinary

FIG. 60. Boot completed. Last layer is one of Unna's paste, and when this layer has almost set it is dusted with talcum powder. Note support given to this leg which like uncovered extremity is site of extensive varicose veins.

wide paint brush and should be of the consistency of thick cream or thin "batter." The paste constituting the first layer is applied directly to the skin. Over this are applied two or

three layers of loose-meshed roller bandage, the bandage being cut directly across instead of folded at points where "reverse" turns would otherwise be necessary. Over the gauze a second coating of Unna's paste is applied, and over this two or three more layers of gauze. The last layer of Unna's paste is applied over this and the entire boot is allowed to "set" in the open air. It is, of course, essential that the application of such boots should be made with the limb well elevated and drained of edematous fluid and blood. The Unna's paste boot need be changed only when it becomes soiled or loose.

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Chapter XV

MISCELLANEOUS POSTOPERATIVE COMPLICATIONS

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Chapter XV

MISCELLANEOUS POSTOPERATIVE COMPLICATIONS

1. Postoperative Hernia

A. Etiology: Doubtless there are certain cases in which by virtue of organic disease, underdeveloped musculature, unavoidable infection of abdominal incisions, and the like, postoperative incisional herniation cannot be avoided, but it is probably true as a general rule that such an occurrence not secondary to preexisting peritonitis is a direct reflection on the judgment and ability of the attending surgeon and his assistants. Postoperative hernias occur most frequently as a result of (1) wound infection, (2) improper use of drains, (3) faulty and careless apposition of anatomical layers, especially the fascial planes, (4) the use of coarse suture material, strangulation of considerable portions of tissue by ligatures in the process of controlling hemorrhage, and large, improperly tied knots, (5) the improper use of stay, or relaxation, sutures, (6) careless use of hemostats with consequent devitalization of tissue and subsequent sloughing of the devitalized tissue in the wound, (7) improper incisions, (8) postoperative straining and vomiting, and (9) postoperative distension and urinary retention.

Masson[1] reporting statistics from the Mayo Clinic for the five-year period from 1915 to 1920 states that 2 per cent of 28,970 abdominal operations were for postoperative hernia. Southam[2] reports a similar percentage from the Manchester Royal Infirmary. Nassau[3] states that 0.3 per cent of all patients subjected to operative procedures involving extensive and prolonged drainage develop postoperative hernia. Masson[1] found that 33.8 per cent of all postoperative hernias occurred through low midline incisions.

B. PROPHYLAXIS: Obviously the prophylaxis of this condition falls more properly within the province of a treatise on operative technique than one on preoperative and postoperative treatment, but recognition of the etiology of the condition is important in that it stimulates added caution in the postoperative treatment of cases in which the operative technique is known to have been imperfect.

II. POSTOPERATIVE WOUND RUPTURE

A. DEFINITION AND DIAGNOSIS: Wound rupture is a condition which is occasionally encountered. It occurs late in the postoperative period, usually from the seventh to the twelfth postoperative day, and often without premonitory signs, i.e., in the absence of infection and drainage. Commonly, however, the wound is seen to exude a watery blood-tinged material, and frequently the general condition of the patient is poor. For this reason wound rupture should always be suspected in those cases in which there is a profuse serosanguinous discharge from the abdominal wound and the patient is vomiting and otherwise convalescing unsatisfactorily.

In wound rupture all the layers of the wound give way widely, or in some cases all layers below the skin; intestinal loops may escape in the latter case through the deeper layers of the abdominal wall and come to lie just below the skin; adhesions between them and the abdominal incision may become so firm as to cause kinking and obstruction. The latter condition results so frequently that all patients with postoperative vomiting in whom obstruction is suspected should be investigated from the point of view of wound separation. Probing of the wound will usually make clear the condition of affairs in case the skin has closed, and without probing clarification of the etiology of the vomiting is usually impossible, for the skin is sometimes apparently well healed and exhibits neither redness, swelling, nor secretion from the wound margins. In the usual case, however, the diagnosis is sufficiently obvious because local bulging can characteristi-

cally be seen in the region of the operative incision, and this bulging is increased on coughing and straining.

B. ETIOLOGY: Among the various causes of wound rupture have been mentioned (1) unusual strains, (2) infection, (3) debilitation and anemia, (4) serous effusions and hematomata in the wound, (5) increased acidity due to systemic intoxication, and (6) protrusions of omentum through improperly or imperfectly closed tissue planes.

Most of these factors may be partly or wholly responsible for wound rupture in certain cases, but there are rather cogent reasons why certain of them cannot be considered as accounting for any considerable number of instances. If unusual strains were a frequent cause of wound rupture, the condition might well be expected to occur with a far greater degree of frequency than it does, because even though "unusual strains" be construed rather narrowly such strains occur far more frequently than wound rupture. Infections almost certainly account for very few cases of true wound rupture; of course, as is well known, infections of laparotomy wounds do cause disintegration of a greater or smaller amount of tissue, but even when an open sinus develops between the peritoneal cavity and the exterior surface of the abdomen, the wound usually ceases to break down as soon as drainage has become adequate, and in true wound rupture there is characteristically no such tendency; furthermore, cultures of material taken from cases of wound rupture are characteristically relatively sterile. Against the etiological importance of debility and anemia can be urged the fact that when wounds which have undergone rupture are subsequently closed by surgical means they usually undergo prompt and satisfactory healing; it is, however, clinically true that wound rupture occurs with a relative degree of frequency in connection with carinoma in which cachexia is a prominent finding. Hematomas or evidences of preexisting hematomas are rarely found in cases of wound rupture, but Lahey[4] suggests that the cause for wound rupture may frequently be found in failure to obliterate the dead

space between the edges of muscles in cases in which a muscle-splitting incision has been used; a consequent accumulation of serous exudate results, and this hinders the process of repair.

The hypothesis of increased acidity which has been championed by Weber[5] is purely a hypothesis, and, furthermore, if it is to be accepted some explanation must be offered for the ease with which healing is stimulated subsequently by secondary suture. Freeman's[6] hypothesis is very ingenious and may account for many of the cases. According to his theory some hiatus in the suture-line serves to initiate the process; through this hiatus a small piece of the omentum finds its way; constriction of this portion of omentum occurs at the suture-line, and edema of the entering wedge of tissue ensues; this edema still further separates the wound edges, and more omentum follows; the process is repeated again and again until the whole wound breaks down.

c. Treatment: The treatment of cases of wound rupture consists in reopening the incision, separating any adhesions which may have formed between the walls of the incision, omentum, and intestinal loops, gentle replacement of the eviscerated organs and secondary suture of the abdominal wall.

Theoretically secondary suture should be performed carefully layer by layer just as in the case of the primary closure, and in a certain percentage of cases such a procedure may be entirely feasible. In many or most cases, however, secondary tissue changes have occurred to such an extent that tissue planes can be recognized only with difficulty, if at all, and the surgeon should in such cases feel quite content if he can replace the contents of the abdomen and appose the sides of the wound by "through and through" sutures including the entire thickness of the abdominal wall. Such sutures should consist of non-absorbable material, such as silk, linen, or silkworm gut, and should not be drawn too tightly. In the most difficult cases advantage should be taken of the Mikulicz type of drain, the wound being left open. Secondary closure of the wound is usually best performed under local infiltration anesthesia,

the straining incident to the administration of a general anesthesia being inadvisable for obvious reasons. As a rule following such treatment healing takes place kindly and without the occurrence of postoperative herniation.

III. Parotitis

A. Historical. According to Charlton[7] postoperative parotitis was first described by Munde[8] in 1878. As early as 1886 Paget[9] was able to collect 101 cases, half of which occurred in connection with operations on the female genitalia and the other half in connection with various other intra-abdominal operations. In 1889 Hanau[10] originally propounded the theory that postoperative parotitis occurs by extension of infection from the mouth by way of Stenson's duct.

B. Clinical Classification. Cases occur (1) of acute primary inflammation of the entire gland, and (2) showing symptoms of recurrent duct obstruction.

C. Etiology. It is generally accepted at the present time that most of the cases of postoperative parotitis result from an ascending infection of Stenson's duct. Probably some cases represent metastatic foci from a blood-borne infection, and possibly some cases occur as a result of lymphatic extension.

The fundamental predisposing cause seems to be dryness of the mouth. Thus in a series of 1000 cases of gastric ulcer treated medically there was an incidence of 4.5 per cent of parotitis in 450 cases treated by oral starvation, whereas there was an incidence of only 0.4 per cent of parotitis in a series of 530 cases in which food was allowed by mouth (Charlton[7]).

In addition to dryness of the mouth the structure or character of the gland must also be a predisposing cause, since whereas infection of the parotid gland is not an infrequent complication, inflammation of the other salivary glands, submaxillary and sublingual, occurs but rarely. Lynn[11] explains this on the basis of the fact that the parotid gland is essentially a serous gland whereas the submaxillary and sublingual glands are essentially mucous glands, and according to Stuart Low[12]

mucin has an inhibitory effect on the growth of bacteria. Charlton[7] calls attention to the fact that the parotid gland also contains lymph nodes, whereas the other salivary glands do not, and believes that the presence of these nodes favors the spread of infection.

Although no evidence has ever been presented directly to substantiate the hematogenous origin of postoperative parotitis, Buscarlet and Kaiser[13] abroad and Jennings[14] and Fisher[15] in this country believe that the condition arises as a metastasis from purulent foci elsewhere in the body. Against such a theory are the following two rather cogent arguments: (1) Positive blood cultures cannot usually be obtained in cases developing postoperative parotitis, and (2) operative procedures which pursue an entirely aseptic course may be complicated by parotitis.

Charlton[7] does not believe that trauma to the parotid gland by pressure of the anesthetist's finger during the course of the administration of an anesthetic as emphasized by some authors is of any importance as an etiological factor, inasmuch as in his experience the complication is as apt to occur after spinal and local analgesia as after general inhalation anesthesia.

D. Age and Sex Incidence. According to Charlton[7] postoperative parotitis accurs more frequently in adults than in children, more frequently after the third decade of life than before, and more frequently in females than in males; also he states that the condition is particularly likely to occur during the months from November to April, i.e., the time of the year during which respiratory infections are most prevalent. About one-quarter of the cases are bilateral, three-quarters unilateral.

In a series of 6100 cases of coeliotomy reported by Collins, there were 8 instances of parotitis, an incidence of 0.13 per cent; one of the cases occurred, however, previous to operation rather than afterward.

In a series of 2716 cases in which major operative procedures had been performed Charlton[7] found 13 cases of postoperative parotitis, an incidence of 0.47 per cent.

E. BACTERIOLOGY. The infectious organism most commonly recovered from cases of postoperative parotitis is the staphylococcus. The pneumococcus, streptotoccus, and bacillus coli are occasionally recovered, and the order in which they have just been named is presumably the order of importance. Hellendale[17] has reported one case in which the gonoccocus was recovered from the parotid gland.

F. CLINICAL PICTURE. Most frequently postoperative parotitis occurs within from two to ten days after the operative procedure; occasionally the time interval is considerably longer as in one case reported by Fowler[18] in which the symptoms developed only after eighteen days. The first symptom is elevation of the patient's temperature, sometimes as high as 104° or 105°, and corresponding increase in the pulse rate. At the same time there develops severe pain in the region of the parotid gland and swelling of the tissues in the parotid region. The severity of the pain is probably to be attributed to the architecture of the gland: inasmuch as the gland is traversed by many strong fibrous connective tissue septa which permit of little distention of the gland substance. For this reason also, extension from one lobe of the gland to the adjacent lobes may be quite slow, although eventually the entire gland may become actively involved.

Sometimes the condition pursues a relatively benign course; the local pain is moderate, the swelling slight and localized strictly to the region of the gland. In other cases the condition may become alarming, due to the development of symptoms of profound sepsis, the patient developing a spreading edema of the neck, face, and head accompanied by high fever, chills, and intense local pain.

The range of temperature is from 99° F. in the mild cases to 105° F. in the severe cases, and the pulse rate varies *pari passu* between 110 and 130. The leucocyte count usually ranges between 10,000 and 25,000.

The differential diagnosis is usually not difficult. Only in those cases in which there is some focus of infection in the

immediate vicinity is there likely to be confusion. In such cases lymphadenitis and cellulitis must be differentiated.

G. TREATMENT. Taking every factor in the etiology into consideration, the prophylactic treatment includes:

(1) Preoperative attention to the oral hygiene of the patient,

(2) Avoidance of trauma to the region during the administration of anesthetics,

(3) Avoidance of postoperative dehydration of the oral cavity, and

(4) Prophylactic chewing movements during the early portion of the postoperative period.

In the simpler non-virulent types of the disease spontaneous resolution may be expected to occur, and this may be hastened by the application of either hot fomentations or cold compresses over the involved area; equally good authority can probably be cited for both variants. When it is possible to open the patient's mouth sufficiently widely the medical attendant should seek to determine the patency or non-patency of Stenson's duct; this may be done either by manipulation of the gland to see whether saliva can be expressed from the duct or in doubtful case by probing the duct. If an obstruction is encountered or suspected a skiagram should be made to determine the presence or absence of a salivary calculus. If an obstruction can be demonstrated it must be overcome by surgical means; usually the opening of the duct requires to be split.

Operative intervention of a more radical nature is required (1) when the parotitis is fulminant from the start and (2) when an initially more benign type of the condition becomes progressively more malignant. In no case should incision and drainage be delayed for more than forty-eight hours because of the danger of extensive suppuration and even gangrene of the gland.

Obviously the precise indication for incision and drainage is suppuration but because of the firmness of the capsule of the

parotid gland it is usually by no means possible to be sure whether actual suppuration has or has not occurred, fluctuation being extremely difficult to elicit.

Lilienthal[19] advises the use of a curvilinear incision starting just in front of the auricle of the ear and just as close to it as possible, extending the incision downward behind the angle of the jaw and then forward as far as the anterior border of the masseter muscle; this incision extends only through the skin; the flap thus formed is gently dissected forward so as to expose the greater part of the fat and fascia overlying the parotid gland. One incision or multiple incisions are then made through the parotid fascia into the substance of the gland itself; these incisions should radiate in the general direction of the fibers of the *pes anserinus*, and no incision should be made actually along the course of Stenson's duct. Deep collections of pus not thus directly accessible may be evacuated through the same cutaneous incision, by opening a tract through the fascia behind the angle of the jaw, subsequently enlarging the tract by Hilton's method.

The death rate in postoperative parotitis may be as high as 40 per cent, and is 5 to 10 per cent lower when only those cases which have been drained are considered. The relatively high mortality is not altogether due to the parotitis, because the general condition of the patient apart from this particular complication is frequently bad.

IV. Postoperative Hiccough (Singultus)

A. Etiology: The etiology of singultus in the postoperative case, as indeed in other cases, is still obscure in spite of the fact that this complication has been known and discussed from the earliest times. Even the manner of production of the spasmodic effort known as hiccough is not entirely settled, although it is generally believed that it represents a clonic contraction of the diaphragm; there is evidence for believing that occasionally only one-half of the diaphragm is involved in this spasm.

It is assumed that singultus occurs as the result of simulation of the respiratory center (a) directly by mechanical means, as the result of cerebral disturbances, (b) indirectly by toxins carried to the center by way of the blood stream, or (c) reflexly through the sensory fibers of the phrenic, vagus, and splanchnic nerves, as a result of peritoneal irritation. The latter mechanism is probably of relatively greater importance than the others, and it is assumed to account for by far the greater number of cases of postoperative singultus. It must be remembered, however, that singultus is frequently a symptom of some gravity in a host of conditions not connected with surgical procedures, tabes dorsalis, hydrocephalus, tuberculous meningitis, tuberculosis of the pons and cerebellum, to mention some of those possibly giving rise to direct stimulation of the respiratory center, and any condition in which toxemia is a prominent factor, such as the acute infectious diseases, may give rise to toxic circulatory stimulation.

Hiccough follows operations on the biliary tract with more frequency than other operative procedures; possibly this fact is explained by the proximity of the invaded area to the lower surface of the diaphragm.

Singultus occurs much more frequently in men than in women, and an attempt has been made to explain this sex distribution on the basis of the abdominal type of breathing found in men.

Postoperative singultus usually subsides spontaneously and without giving much cause for anxiety. Occasionally, however, it becomes a most distressing complication and one which may sometimes so debilitate the patient as to cause an adverse shift in the prognosis. In every case in which treatment for singultus is required an attempt should first be made to locate the source of some possible reflex irritation.

B. TREATMENT: The frequency with which singultus ceases after the stomach has been washed out in certain cases and after drainage tubes have been removed, from the region of the common bile duct or from the stomach or an iliostomy in

other cases strongly suggests that the factor of mechanical irritation may frequently be a predominant one. In many cases, however, the search for the *causa causans* is unproductive and in these cases, the cause of the singultus not being discoverable, the treatment must be largely symptomatic. Many general means have been devised for the relief of this condition, the very multiplicity of the proposed measure being a good indication that no one of them is uniformly successful. In addition to the use of various household remedies these include:

1. Physical measures
   a. Application of a tight abdominal binder
   b. Forced flexion of the thighs on the abdomen
   c. Passage of the esophageal sound
   d. Repeated gastric lavage with quantities of warm sodium bicarbonate solution
   e. Stimulation of vomiting
   f. Holding the breath
   g. Massage
   h. Drinking water while holding the breath
2. Drugs
   a. Administration of one drop of tincture of iodine in a teaspoonful of water every fifteen minutes for six doses
   b. Cocaine per os or per hypodermic
   c. Morphine per os or per hypodermic
   d. Chloral hydrate
   e. Bromides
   f. Barbital derivatives
   g. Epinephrine
   h. Luminal
   i. Chloroform anesthesia
   j. Active cathartics
   k. Active emetics

Carbon dioxide inhalations are perhaps as frequently successful as any type of treatment. In persistent hiccough

inhalation of a mixture of 90 per cent oxygen and 10 per cent carbon dioxide will almost invariably relieve the diaphragmatic spasm within twenty minutes; the effect may be permanent, or a relapse of symptoms may occur within an hour or so. The rationale of the procedure is not altogether clear, but in effect regular, rapid, and powerful contractions of the diaphragm are substituted for irregular and spasmodic ones, i.e., the diaphragmatic rhythm is altered. In administering the treatment a regular anesthetic machine may be used or if this be not available a funnel or cone is simply attached to the outlet of a carbon dioxide tank and the latter is opened until there is a distinct smell of escaping gas; the patient is now allowed to take repeated inhalations from the funnel, soon after which the hiccough usually disappears. If singultus recurs the treatment is repeated as often as necessary.

In intractable cases operative attack on one or both phrenic nerves has become an accepted procedure.

The intimate relationship between the phrenic nerve and hiccough must have been appreciated for many years, for according to Weeks[20] as early as 1833 Shortt[21] of Edinburgh advised that in cases of intractable hiccough one should produce blisters over the origin and course of the phrenic nerve in the neck; he reported several cases treated successfully in this manner.

Grognot[22] in 1885 and Leloir[23] in 1892 recommended the use of digital pressure over the phrenic nerve in the neck, and this device has some advocates at the present time. Capriati[24] in 1898 and Regis and Debedat[25] in 1897 recommended the application of galvanic and faradic currents of electricity to the region of the phrenic nerve in the neck for the same purpose.

As a result of the demonstration in 1911 by Stuertz[26] and Sauerbruch[27] of the possibility of paralysing the diaphragm by surgical sectioning of the phrenic nerves the foundation was laid for direct operative attacks on the phrenic nerve as subsequently practised. In ascending order of radicalism these

direct operative attacks include (1) injection of one or both phrenic nerves with novocaine; (2) freezing of one or both phrenic nerves with ethyl chloride; (3) monolateral or bilateral phrenico-phraxis; (4) monolateral or bilateral phrenicotomy, and (5) monolateral or bilateral phrenico-exairesis.

Amongst those authors who have reported successful results following the use of local anesthesia are Kroh[28] in 1917, Goetze[29] in 1920, Erkes[30] in 1921, Kummel,[31] Payr, Ghose[32] in 1926, and Jirasek.[33]

Amongst those authors who have successfully used freezing methods are Kroh,[34] Kuttner,[35] Goetze,[36] and Dowman.[37]

The more radical procedures have been performed in but relatively few instances: phrenico-phraxis by Weeks[20] in 1931, phrenicotomy by Kroh[28] in 1921 and 1922, Lehmann[38] in 1923, Oehler[39] in 1922, and Dowman[37] in 1927, and phrenico-exairesis by Kroh[28] in 1921, Kappis[40] in 1924 and Weeks[20] in 1931.

The disadvantage of novocaine injection is the shortness of the duration on the effect, three to eight hours in favorable cases; freezing of the nerves seems to produce a somewhat more prolonged effect, and phrenico-phraxis a still somewhat more prolonged effect.

Phrenicotomy produces a permanent paralysis, especially if a short portion of the nerve be excised to prevent the possibility of regeneration.

Phrenico-exairesis possesses the advantage over simple phrenicotomy that not only is the nerve trunk in the neck divided, but, if the proper technique is used, any tributaries which the phrenic nerve may receive further down in the thorax are also interrupted because they are torn away.

Bilateral paralysis of the diaphragm is a procedure which should not be invoked on slight provocation, but it is not at all inconsistent with life provided the accessory muscles of respiration are capable of performing their function in the normal manner and providing there is no gross intrathoracic disease such as to reduce markedly the vital capacity of the lungs.

In treating intractable hiccough the suggestions of Weeks[20] seem to be eminently rational: "If all the usual methods of treatment fail, the patient should be fluoroscoped to determine which side of the diaphragm is involved. The phrenic nerve on the side involved should then be exposed under local anesthesia, and a stout silk ligature passed about it. The nerve can then be anesthetized. This effect apparently lasts about eight hours. Following this, traction should be tried, and if it fails the nerve can be easily exposed and crushed. If at the time of operation, novocaine block and traction both fail, it should lead one to believe that there is nerve anastomosis below the site of section or blocking, and the nerve should then be avulsed. If both sides of the diaphragm are involved, then both phrenics should be exposed and blocked either temporarily or permanently."

v. Postoperative Heat Stroke

Postoperative heat stroke is a rare complication of surgical procedures; at least, since the first description of the condition by Gibson[41] in 1900 only very few cases have been reported. Gibson himself reported 2 definite cases and a third probable one. In discussing Gibson's report, Brewer[42] reported an additional case, and Johnson[43] reported 3 cases. Crandon and Ehrenfried[44] in 1912 added 3 cases, Moschowitz[45] in 1916 added 5 more, Botteselle[46] in 1923 described 7 cases confirmed at autopsy, and Martin[47] in 1928 completed the list with 4 cases.

a. Etiology, Signs, and Symptoms: The designation "heat stroke" indicates the essential etiology as heat, but inasmuch as excessive heat produces several somewhat different disease syndromes, the differentiating features between this variety of heat effect and others like "sunstroke" and "heat prostration" must be somewhat more closely drawn.

Sunstroke, as the term indicates, develops as a result of direct exposure of a patient to the sun's rays; the onset of the

condition is abrupt with complete loss of consciousness, heat, dryness, and flushing of the skin, a pulse of high tension, and a very high general body temperature. Heat prostration, on the other hand, occurs in persons who are exposed to extremes of heat within doors, often artificial heat, and is particularly likely to supervene when persons work in confined and poorly ventilated rooms; the onset of this condition is gradual rather than abrupt, consciousness is usually not lost, the skin is pale, cold, and clammy, the pulse weak and thready, and the temperature subnormal, normal, or somewhat elevated, though it rarely exceeds 100°F.

Postoperative heat stroke conforms to neither of these clinical pictures exactly. It characteristically develops in patients who have been protected from the direct rays of the sun for a number of days. Little is known about the exact mode of onset, for the condition ensues so closely upon the operation in most cases that it is well nigh impossible to say just where the operative and anesthetic effect leaves off and the condition of heat stroke begins. However, the one diagnostic characteristic of the condition is the development of hyperpyrexia, ensuing within a very few hours after operation and characteristically reaching from 105° to 109°F. The skin has been described as hot and dry in most cases. The condition and character of the pulse cannot safely be assumed to be of any particular significance so closely following an operative procedure. Mentally the patients have usually been described as delirious or irrational. Heat stroke thus appears clinically to resemble sunstroke in most particulars, although direct exposure to the sun is not the exciting cause, and the patients are not completely unconscious.

Cases have been reported from Boston, New York, and Rome (Botteselle). They have occurred during what is commonly called a "heat wave," by which is meant a period of long continued high temperature with a maximum of atmospheric humidity and a lack of breeze. It has been assumed that the development of heat stroke is favored by too

closely covering patients with heavy blankets, by the unwise application of hot water bottles, by dehydration, and by inadequate ventilation.

B. TREATMENT: The treatment of the condition is fundamentally prophylactic and involves avoidance of operations of election during particularly warm and humid weather, and in case operations are necessary at such times the avoidance of needless swathing of patients in thick blankets, the prodigal use of hot water bottles, and failure to supply adequate ventilation.

In the developed case the treatment is merely symptomatic. The indication is for reduction of temperature, and in reducing the temperature reliance should be placed not upon drugs but upon physical measures. An ice cap should be applied to the head, sponge baths of cold water should be applied to the body, ice water enemata and gastric lavage with ice water may also be given. The ice pack as given to patients who develop postoperative thyroid storms should prove very valuable.

VI. CHRONIC MALARIA AS A POSTOPERATIVE COMPLICATION

Chronic malaria as a possible postoperative complication is probably not sufficiently well recognized. In cases developing this complication sometimes no malarial history can be obtained preoperatively, though characteristically such a history can almost always be elicited if the attempt be specifically made. The complication manifests itself usually after five or six days of uncomplicated recovery, occasionally after a much longer period. It is initiated by a rise of temperature which may, on the one hand, be gradual and insidious, or, on the other hand, abrupt, following a chill. Almost invariably wound healing is delayed, the wound edges becoming swollen and painful, a serosanguinous exudate issues therefrom, and the wound tends to break down and gape. The urine frequently shows numbers of red blood cells. Careful microscopical examination of the blood at this time shows the presence of plasmodia, although previous to the operation they may have been entirely absent.

The administration of quinine hydrochloride intravenously or the sulphate by mouth (20 to 30 grains daily for four days followed by 10 grains daily for thirty days) is specific. Quinine

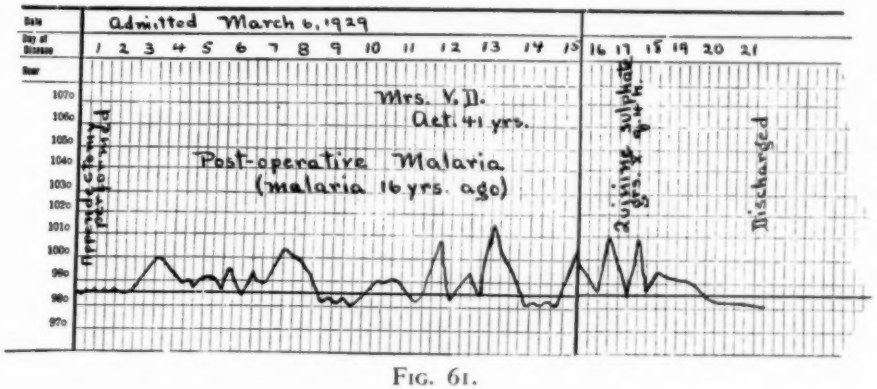

FIG. 61.

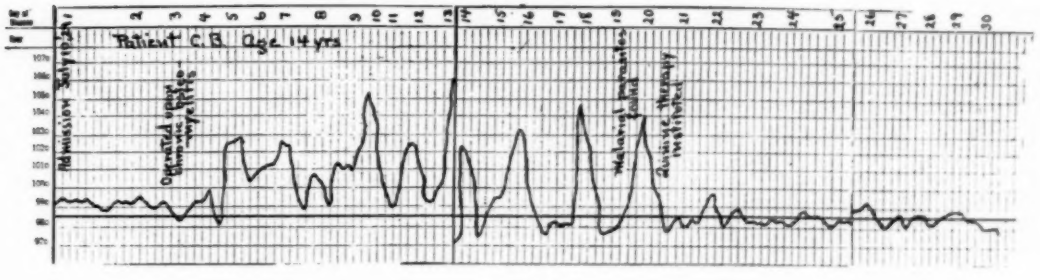

FIG. 62.

FIGS. 61 and 62. Clinical charts of two patients who developed postoperative malaria on the surgical service of Dr. Alton Ochsner, Charity Hospital of Louisiana, New Orleans. The first patient had been subjected to the operation of appendectomy and developed characteristic symptoms only after ten days, although convalescence had previously been unsatisfactory; administration of quinine sulphate relieved complication completely within forty-eight hours. The second patient had been operated upon for chronic osteomyelitis and developed the typical symptomology of postoperative malaria at the end of six days, although the true nature of the condition was appreciated only after sixteen days at which time malarial plasmodia were sought and found in the blood; in this case malaria was not suspected at first because of septic nature of primary process. Quinine therapy relieved this patient immediately.

When specifically questioned both patients gave a definite history of preoperative malarial infection.

salts seem to act better if administered with a dilute acid, either dilute hydrochloric or sulphuric acids. Both constitutional and local conditions improve quickly under this therapy.

Because the complication yields rapidly and completely to the treatment outlined here, the danger lies not in inability to combat the condition once it has been recognized but rather in its recognition. (Slocumb[48])

VII. Postoperative Gas Bacillus Infection of Abdominal Incisions

Infection of abdominal wounds with gas bacilli is a very rare complication but one which has been reported and one which is very serious when it does occur. Butler[49] has reported 2 cases occurring in a series of 7000 laparotomies. Previously Beer[50] reported a case which occurred within forty-eight hours after appendectomy and, Ochsner and Schmidt[51] also reported a case following operation for a perforated appendix accompanied by abscess formation. All of these patients made good recoveries under appropriate treatment. Apparently the contamination is derived from the intestinal tract, and various observers have found the offending organisms, B. tetani, B. welchii, vibrion septique, B. edematiens, B. fallax, B. sporogenes, B. histolyticus, B. putrificus, in various parts of the intestinal tract of operative cases, including the appendix.

The condition may be suspected when a sudden increase in pulse rate is observed, with or without a rise in temperature, in cases in which a patient is not doing well after operation. The presence of a brownish, foul-smelling discharge from the wound with local edema and crepitation make the diagnosis presumptive, and positive bacterial smears or cultures clinch the matter.

The treatment consists of promptly made multiple incisions, the institution of free drainage, and the administration of adequate doses of antiperfringens or Bull serum. The prognosis depends largely upon the extent of the infection, the early recognition of the condition, and the institution of early and adequate drainage.

VIII. Postoperative Psychoses

The unexpected development of frank postoperative psychoses is frequently a reflection on the diagnostic acumen

of the medical attendant who previously performed the preoperative examination. Surgeons with a background of psychiatric training should be able in a considerable percentage of such cases to recognize minor mental aberrations and by careful history taking to reveal psychotic tendencies or previous psychotic states. Frequently that surgeon is wise who, when dealing with patients presenting definite eccentricities, requests a preoperative psychiatric consultation.

Not only is it important preoperatively to recognize the frank psychopathias, but feeble-mindedness and subnormal mentality in general are inconsistent with a patient's satisfactory cooperation in many cases. Much embarrassment may occasionally be saved if the mental status of the patient is appraised before some gross mishap occurs through assuming that the patient possesses more intelligence than he is really able to command.

The development of a postoperative psychosis is not an event of very frequent occurrence. In cases in which it does occur there is often either a hereditary taint, or else toxemia, exhaustion, or allied states are present as predisposing causes. The development of such a condition immediately following operation is considered as due to the anesthetic, i.e., as a toxic manifestation; following the operative procedure by several days the operative procedure itself is incriminated.

Females and males are affected in about equal proportions, and the incidence is slightly higher following operations on the genital organs. In the average case complete recovery may be expected within three months, though certain patients recover much more promptly, whereas a certain small percentage never recover. (Brown[52])

One type of psychosis which is particularly apt to occur in connection with operations upon the aged, particularly such operations as prostatectomy, is the condition known as "acute hallucinosis." Eastman and Kilman[53] have emphasized the fact that the aged person, like the child, is affected to an abnormal degree by slight changes in environment. The

elaborate display of new furnishings, the strange garb of attendants, and the type of community found in the modern hospital perturb the aged person inordinately. He longs for the presence of his friends, and often seeks even in his sleep for familiar faces and familiar objects. Seeking relief from distasteful ever present realities, he may take refuge in auditory and visual hallucinations. He may even develop low grade delusions of persecution, which result in distrust of his medical attendants and the nursing staff; this is sometimes carried to the point of a complete change of personality in which there occur only a few lucid moments during the course of the day. Probably the derangement belongs to the group of psychoses which are often termed "exhaustion psychoses," and the background for the development of this condition is found in exertion incident to the patient's attempted adjustment to unusual surroundings. This complication is not to be regarded too lightly since it often results in nutritional disturbances. It may result seriously or fatally in patients who initially are reduced in vitality.

The condition is occasionally of so serious moment that it becomes highly desirable to employ some form of immediate relief. Probably the best method of relieving the condition in cases in which such a procedure is feasible is to send the individual home in an ambulance, and thus reestablish the continuity of his life at the point at which it was broken by his entrance to the hospital. Occasionally minor degrees of acute hallucinosis may be combated by allowing the wife, or friends, to remain in virtually constant attendance at the patient's bedside.

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